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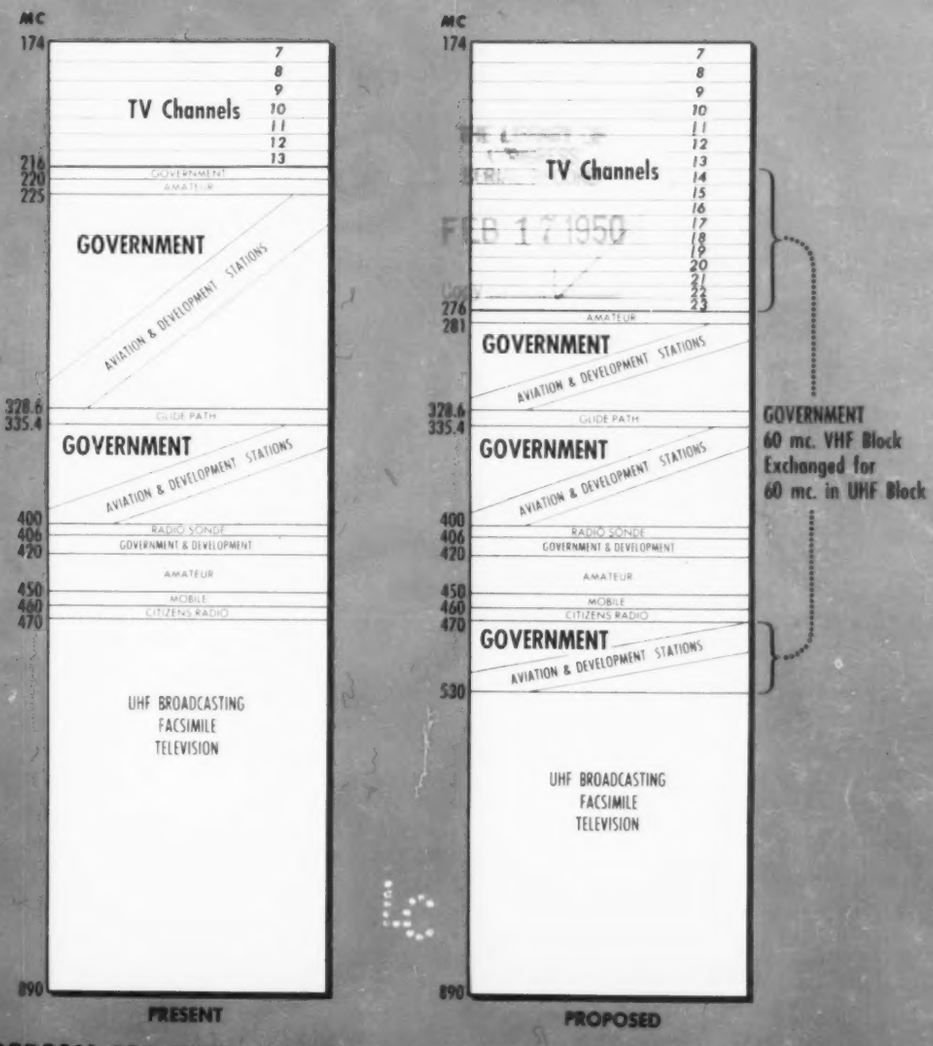

TELE-TECH'S PROPOSAL FOR EXTENDING THE PRESENT VHF TV BAND BY TEN ADJOINING CHANNELS

BROAD CAST	GOVERNMENT	AMATEUR	AVIATION, MOBILE, COMMON CARRIER, ETC.
5%	42%	7%	46%

Percentages of Radio Spectrum Assigned to Principal Classes of Use—Comparing Government's 42% with the Crowded 5% Allocated to All Broadcasting (AM, FM, TV)!

0-KC Disc Recording
TV Interference Filter Design
Worldwide Radio-TV Statistics

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RCA VICTOR Sparton
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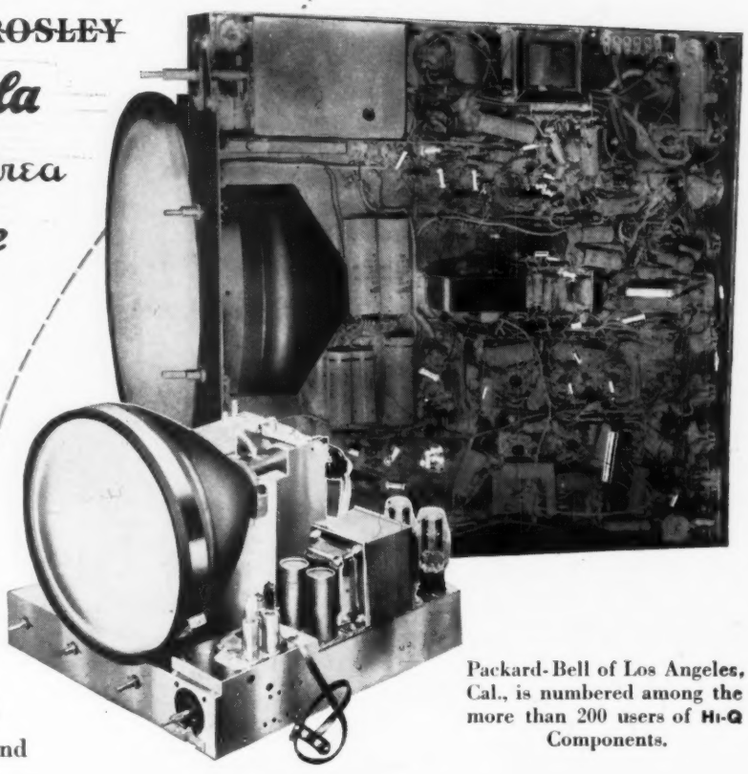
ZENITH RADIO STROMBERG-CARLSON

...and most other radio and TV producers specify and use **Hi-Q** Components.



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Most leading radio and TV builders... and scores of other electronic manufacturers too ...are consistent users of **Hi-Q** Components. The fact that they order again...and again ...and again is the best recommendation we know for **Hi-Q** service, dependability and performance.

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Edited for the 15,000 top influential engineers in the Tele-communications industry, Tele-Tech each month brings clearly written, compact, and authoritative articles and summaries of the latest technological developments to the busy executive. Aside from its engineering articles dealing with manufacture and operation of new communications equipment, Tele-Tech is widely recognized for comprehensive analyses and statistical surveys of trends in the industry. Its timely reports and interpretations of governmental activity with regard to regulation, purchasing, research, and development are sought by the leaders in the many engineering fields listed below

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JANUARY, 1950

COVER: THE U. S. TELEVISION SPECTRUM showing how, by transferring 50 MC reserved by the government in the upper part of the VHF channel, room for ten additional TV VHF channels contiguous with the existing channels 7 to 13 could be made. Use of frequencies to 30,000 MC is also analyzed and the allocations to various services are shown as percentages. See pages 11 and 23

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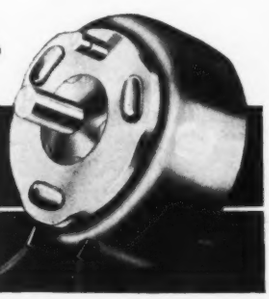

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Sylvania—and *only* Sylvania—brings set manufacturers this group of low-drain battery-type tubes that consume only half as much heater current as previously available types. Requiring only 25 ma filament current, they will triple life of present "A" batteries!

These new tubes also offer opportunities for the design of *smaller* "A" batteries, which will permit manufacture of more compact portables without sacrifice of performance.

The four types include a pentode amplifier, a converter, a diode pentode and an output pentode—forming a complete tube complement for portables. They offer comparable power output and sensitivity to previous types... and give excellent performance with a plate supply of only 45 volts.

Remember . . . these new tubes come to you from the *same* company that first made the 1.4 volt battery tube available!

Typical Operating Conditions

Characteristic	1AF4	1AF5	1U6	3E5
Filament Voltage (volts)	1.4	1.4	1.4	2.8
Filament Current (ma)	25	25	25	25
Plate Voltage (volts)	90	90	90	90
Transconductance (μmhos)	950	600	275*	1100
Plate Resistance (megohms)	1.8	2.0	0.6	0.12
Power Output (mw)	—	—	—	175

*Conversion Transconductance

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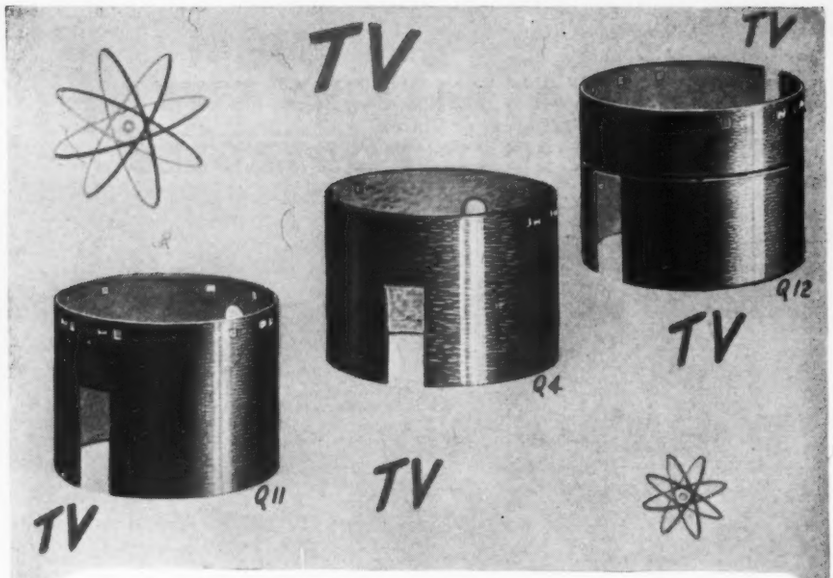

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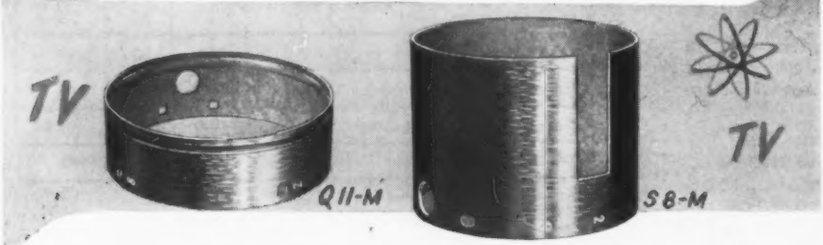

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TELE-TIPS

GLASS vs. METAL—Last year TV receiver manufacturers developed metal cathode ray tubes to get around the costs of glass tube blanks and their acute shortage. Now the glass companies are out to regain the lost trade. They are offering unlimited production of round or rectangular TV bulbs, in any size, lighter and cheaper than equivalent metal types.

NOISY AIRCRAFT RECORDS—We hear that the CAA has still not been able to find a completely reliable recorder to register the conversations between aircraft and control towers. Trouble seems to be that the various noise sources override the intelligence because of the extremely restricted range of voice frequencies transmitted. With the shift of this type of communication to the UHF spectrum consideration may be given to higher fidelity equipment since the higher audio frequencies have greater noise penetrating power.

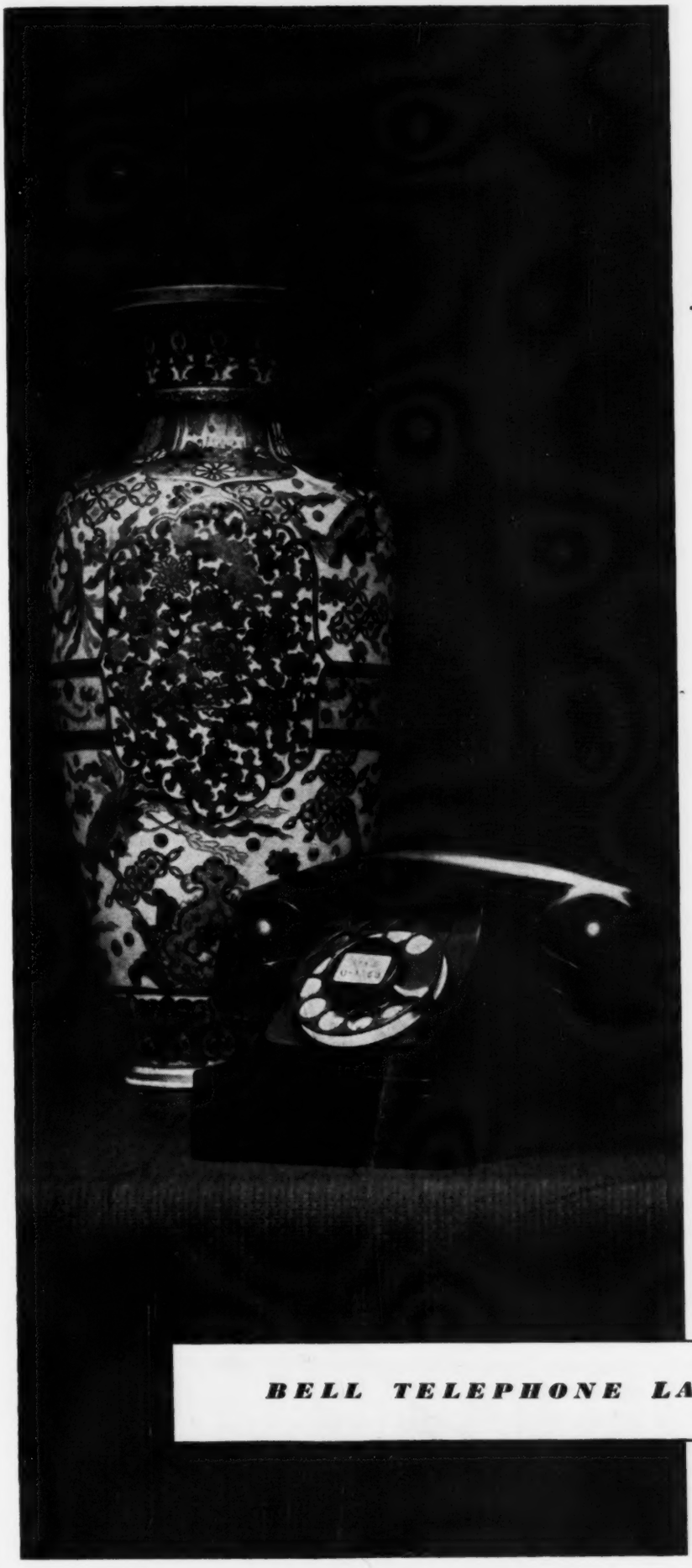
BLEAK BLACKFACE OUTLOOK—In spite of recent announcements describing the virtues of filter-face cathode-ray tubes for TV, sales still seem far short of expectations. One manufacturer with over five thousand finished tubes on hand says that standard tube designs using the 67% transmission-face do not give a bright enough picture.

TO SUPPLY TV with the five million receivers which will be built in 1950, the raw materials needed figure out something like this:

Steel—200 million lbs.
Copper—47½ million lbs.
Aluminum—40 million lbs.
Glass—83 million lbs. (for tubes alone)
Cabinets—103 million board feet

Add to above the many millions of feet of metal tubing for antennas and mounts.

RADIO-ON-HORSEBACK — First radio-equipped horse is claimed by Miami, Florida police department which has saddled one of its equine constabulary with a two-way communication unit. The Miami police say they will have thirteen radio-carrying horses on the force by January 1, for duty at parades and other gatherings.



Your telephone uses ceramics, too!

Five thousand years ago, potters were making household vessels of clay. As skill grew, grace of shape and ornament were added. The beauty of fine china has been recognized by every civilization, while the availability, ease of manufacture and durability of other ceramics have given them wide use.

Your telephone, too, uses ceramics. Behind its dial is a metal plate, glazed as carefully and in much the same manner as this fine piece of pottery. It carries the letters and numbers you dial, so it must resist both fading and abrasion. You will find other ceramics as insulators, supporting wires on pole lines; in eighty thousand miles of underground conduit, where fired clays defy decay and corrosion.

Today at Bell Telephone Laboratories scientists utilize ceramics in ways undreamed of in ancient times. Thermistors, made of a ceramic, provide automatic controls for electric current, to offset fluctuations in temperature and voltage. One kind of ceramic makes low-loss insulation at high frequencies, while another supplies controlled attenuation for microwaves traveling in waveguides.

Each use demands a special composition, scientifically controlled and processed. Basic studies in the chemistry and physics of ceramics have shown how to utilize their versatile properties in electrical communication. And research continues on ceramic materials as well as on every other material which promises better and cheaper telephone service.

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Constant Groove Depth Solves Microgroove Problem

*by D. E. Ward**

Whereas variation in groove depth as small as .0005" little affects the quality of ordinary disc recordings, such variation seriously impairs microgroove results. The fact that uniform depth is difficult to maintain in cutting ordinary aluminum-base transcription blanks or master discs is borne out by the operating procedures of prominent fine-line recording companies. Recording engineers have found it necessary for fine-line work to select only the flattest discs out of their supplies of blanks. Where fine-line cutting is the predominant phase of their business, so relatively few discs are found to be ideally flat, that excessive inventories of less flat blanks quickly accumulate.

To alleviate this selection problem partially, at least, some recording departments use 13¼" or 17¼" discs as originals for even seven inch pressings. Due to the fact that the large master size discs are commonly supplied with .050" aluminum bases, the *chance* of obtaining a better degree of flatness in these sizes is greater.

On the other hand, however, because of the dependence of all disc manufacturers on only one source of aluminum bases, there is no real assurance that even the heavy bases will be *consistently* flat from shipment to shipment. This fact has doubtless been a contributing factor to what has sometimes been termed inconsistent behavior of ordinary coated discs. When, because of surface run-out, the cut changes from light to heavy once per revolution, surface noise may develop a "swish" which is often erroneously charged to hard and soft areas, a condition which actually never occurs on discs manufactured by modern methods.

The best discs bases obtainable often runout of flat as much as .015" at a 12" diameter. The commonly seen wavering of the reflection in a rotating disc is, of course, the plainest evidence of this usual run-out, and is ordinarily the recording engineer's criterion for judgment of flatness.

To eliminate the lost motion of having the user select-out the flattest discs himself, and to minimize the resulting accumulation of inventory, one disc manufacturer, REEVES SOUNDCRAFT CORP., now offers a full solution to the flatness problem by new innovations in the familiar Soundcraft line made possible by the Soundcraft Electronic Selector, an ingenious device which rapidly tests discs for compliance with close flatness tolerances. Soundcraft, therefore, now offers two new lines, 'Micromaster' discs for fine-line originals and New 'Microflat Broadcasters' for high quality, radio reproduction. *Advertisement.*

*Sales Manager—Reeves Soundcraft Corp.

THIS IS THE NEW

'MICROFLAT'
'BROADCASTER' DISC

FOR TRULY CRITICAL RECORDING
UP TO 500 LINES PER INCH!

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- ELIMINATE "TURNTABLE SCRUTINY"
- DON'T PLAY NUMBERS (LOT)

These blanks actually cut as quietly at the critical small diameters as ANY blank will cut at a *LARGE* diameter.

They have always been microscopically clean, free from surface imperfections, and INHERENTLY impervious to humidity.

Now AT NO EXTRA CHARGE, they are also

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Mail to

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10 EAST 52nd STREET · NEW YORK 22, N.Y.

Electronic Selector Picks Out Flat Discs

*by A. C. Travis, Jr**

To meet the urgent need for flatter-than-average discs for all fine-line applications such as 7"-45 RPM and 33-1/3 RPM LP microgroove recordings, an Electronic Disc Selector has been developed by Reeves Soundcraft Corp. for use in Soundcraft Disc production.

Among the many problems attendant upon the development was the determination of standards and tolerances, in other words, "how flat is flat?" Microscopically speaking, there is, of course, no such thing as a perfectly flat surface. For practical purposes, however, it was determined that even the poorest cutting head suspension would produce a uniform groove at any standard speed if the vertical rise and fall of the surface under the stylus was less than .005" provided this run-out was not caused by a sharp bend or bump. Flatness testing all sizes of disc bases further determined that the larger diameters, 13¼", 16" and 17¼" averaged flatter than ten and twelve inch bases, which commonly run-out of flat as much as .015".

Obviously, many ways can be devised for checking discs for flatness, but to check them at production speeds without damage from handling is quite another matter. The disc can, of course, be touched only by the edges, and nothing mechanical can bear against the surface without marring it. The Electronic Selector, therefore, to borrow a political phrase, literally has to "*look* at the record". A combination of optics and electronics, the Selector takes advantage of the fact that the truly flat, broadcasting-quality disc is a perfect darkened mirror. The Selector, therefore, makes use of reflected light beams and photocells to check not only whether the deviation from a truly flat surface is within limits, but also whether the steepness of the curve of deviation is within an allowable tolerance. The Selector makes fast decisions to keep up with Soundcraft's high production rate without sacrificing safety in handling. It would hardly be fair to say that the Soundcraft Electronic Selector is a great invention. The truth is that as a gadget, it is only a new application of prior art. Of *real* importance, however, is the fact that its use makes possible the offer in commercial quantities of remarkably flat recording discs for critical work.

The new selected discs are available in two types: NEW 'MICROFLAT' SOUNDCRAFT 'BROADCASTERS' and 'MICROMASTERS'. The premium-grade Soundcraft 'BROADCASTERS' are now and henceforth being furnished at no extra charge as 'MICROFLAT'. Electronically selected 13¼" and 17¼" 'MICROMASTERS' are now furnished for all fine-line originals at a slight increase in price over the popular 'Maestro' line commensurate only with the cost of the selection operation. *Advertisement*

*Vice Pres.—Reeves Soundcraft Corp.

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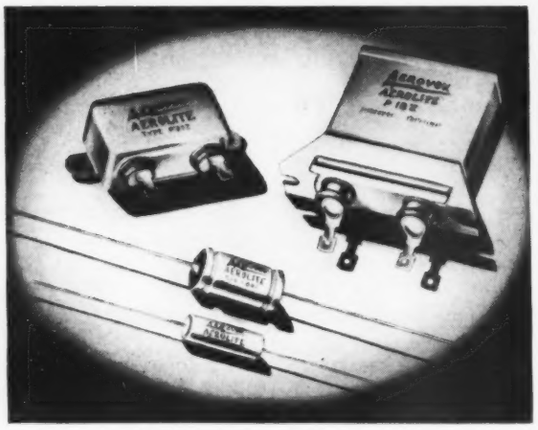

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TELEVISION • TELECOMMUNICATIONS • RADIO

O. H. CALDWELL, Editorial Director ★ M. CLEMENTS, Publisher ★ 480 Lexington Ave., New York (17) N. Y.

Needed—A CONTINUOUS Television Spectrum

(See Front Cover and Page 23)

Already it is clear that television is destined to be one of the most important radio services to the U.S.'s 150 million people.

For this paramount TV operation an adequate *continuous* right-of-way should be created and maintained.

Already television allocations have been needlessly botched by the 86-MC interval between the present low and high bands.

It is now time to block the creation of another such TV absurdity between vhf TV and the uhf, a region still little known.

Television should be allowed to add its needed channels directly adjoining channel 13 and on up to channel 23 (see front cover) making a continuous TV band from channel 7 to channel 23.

★★★★★★★★★★★★★

Such additional channels would quickly nearly double present available TV positions. Immediately, the "freeze" could be lifted, and the problems of TV users, broadcasters, and manufacturers would be immeasurably simplified by setting up these new channels as a continuation of the present high band.

No obstacle stands in the way to this sensible solution but a few government channels and an amateur band. There is nothing sacrosanct about these government channels, when the higher rights of the public itself are involved.

The government has already taken for its own use 42% of our priceless spectrum, and much of this grabbing is indefensible from the standpoint of any present or future peacetime use. (Of course, in event of war, the government instantly gets *all* the radio spectrum!)

★★★★★★★★★★★★★

The spectrum space from 216 to 276 MC should be cleared for TV!

We urge if necessary a Presidential Order, setting aside any spectrum obstacles that have been created in the past by well-meaning but short-sighted government departmental representatives. Such a Presidential Order would make the way clear for an adequate and continuous television band right through to channel 23.

No greater service could be rendered to the uncounted millions of the American public who in a few years will be using television from coast to coast.

Because the obstacle to such television facilities has been unwittingly created by the President's own interdepartmental committee (who casually take any wavelengths they want, assigning "what's left" to the FCC for public allocation)—

It is up to the White House to order, for the larger public good, the slight transfers which will clear the way for a continuous TV band.

The RADARSCOPE *Revealing at a Glance,*

RE-ARMAMENT

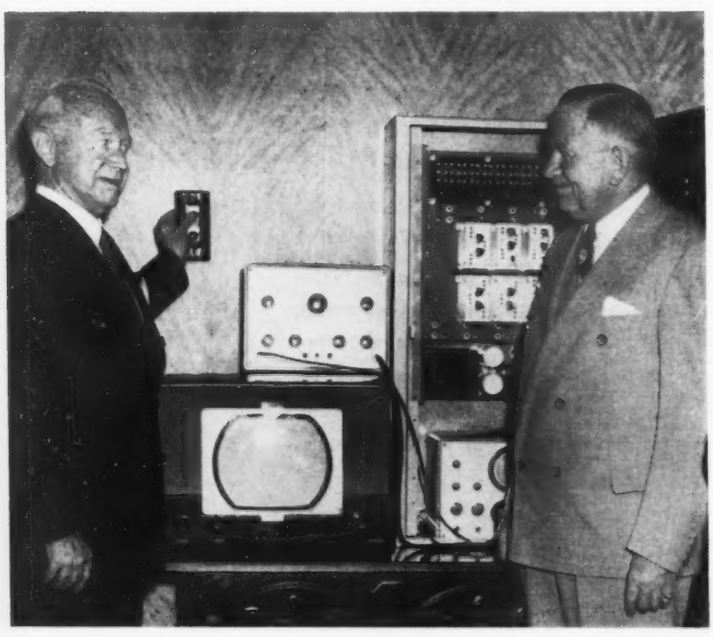
ONE-THIRD OF A BILLION DOLLARS—To be expended on radio communications equipment and components before mid-year 1950, the three armed services have a total of around $375,000,000 for procurement. The Air Force has the largest amount—$163,000,000, a quarter to be spent for tactical electronic systems. $50 million goes for navigation aids. The Signal Corps has $115,000,000 with an added $15-20 million under the North Atlantic Pact military assistance program. The Navy has available $68,472,000 for communications-radar-electronics equipment procurement. Of this the Bureau of Ships' Electronics Division controls the spending of $52,532,000 for equipment needs of the Fleet, Navy shore facilities and the Marine Corps; while the Bureau of Aeronautics has an allocation of $15,940,000 for naval aviation.

FCC OUTLOOK

COMMISSION'S PLANS FOR 1950—Television, both color and settlement of the monochrome video allocations and lifting of the station construction freeze, will occupy the major attention of the Federal Communications Commission during probably the entire year of 1950. Hence broadcasting, mobile radio services and common-carrier wire and radio communications will fall into a secondary place in FCC functioning. But the mobile safety and special radio services with their far-reaching scope of operations in almost every major U. S. industry will be of sufficient importance so that engineer-Commissioner E. M. Webster will keep a continuous supervision over the staff processing of mobile radio matters.

Color television is still uppermost on the FCC agenda, but the situation has become more regularized with calmer and more constructive thinking by the FCC majority in line with the views originally set forth by the radio manufacturers and leading industry engineers. This has been epitomized in the adoption of the industry proposal of field tests.

TV-antenna system for rooms of Hotel Shelton, New York City, is put into operation in presence of RCA's president, Frank M. Folsom



AIRPLANE RADIO

CIVIL AVIATION PROGRAM—1950 will see the major part of the RTCA SC 31 civil-aviation program implemented. VHF Omniranges will be replacing the older LF Ranges which have served long and well. GCA and ILS will be installed at more airports.

The modern aircraft, both civil and military types use a considerable amount of electronic equipment. A modern civil airliner costing up to $1,500,000 may have as much as $150,000 tied up in this type of accessory, the number of different pieces of equipment is sometimes as high as 20, including that used on overseas flights and duplications.

As the broadcast fields shrink, temporarily, many radio manufacturers may turn their attentions to this field and find that it is more lucrative than they expected. The weather ships which patrol a few square miles of ocean for weeks at a time will be increased and in addition to operational equipment they will also carry entertainment receivers for the crews.

MATERIALS, COMPONENTS

NEW PLASTICS AND CAPACITORS—Several plastics have been introduced to the radio-electrical industry that seem to have promise. Teflon (DuPont) has good adhesion to metals, high temperature resistive properties (500°F) and chemical resistance, all of which make it suited for many unusual services.

A survey among representative capacitor manufacturers indicates that the use of titanates as ceramic dielectrics for capacitors to be used in "B" supply filters is still in the laboratory stage, although values in excess of one or two microfarads are at hand. The usual difficulty—cost—does not make ceramics a serious competitor of electrolytics now.

Survey of trends in current television sets show that the use of ceramics in small coupling and bypass applications is increasing rapidly.

MOBILE RADIO

MOBILE RADIO PRESENTS BIG EQUIPMENT POTENTIAL—While little publicized, certain major mobile radio services—petroleum industry, miscellaneous common carriers and the taxicab companies—in their recent conventions in Chicago disclosed the large potential of their radio equipment needs. The Miscellaneous Common Carrier industry, it was estimated by Federal Telephone and Radio Corp., has an equipment potential of $86 million and the possibility of the eventual establishment of a MCC system in every city or town with a population of 25,000 or more. Petroleum industry within two years plans to double its number of fixed and mobile stations from the present 500 fixed and 6,000 mobile units, according to figures from companies which are members of the American Petroleum Institute. In addition, there will be a large number of radio and radar installations aboard tankers and tugs in the marine services of the oil industry.

Radio-equipped taxicabs are now becoming so prevalent, that FCC Commissioner E. M. Webster advised the American Taxicab Association to start immediate experimental use of its 10 frequencies in the 450-megacycle band.

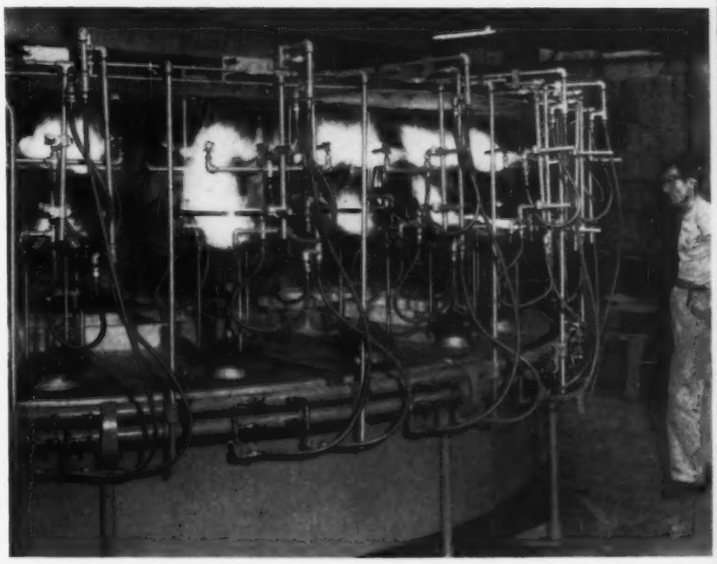
The prospects in mobile radio are being followed closely by manufacturers specializing in the field, including RCA, General Electric, Motorola, Philco, Link, Westinghouse, Raytheon and several smaller companies.

TELEVISION TUBES

LARGER PICTURE TUBES—The ever present public demand for a larger, brighter television picture at an initial lower receiver cost continues to spur the cathode ray tube designers. 1949 developments brought forth the first 16-in. metal cone direct-view picture tubes, the filter type face plate for reducing glare and halation effects, as well as the rectangular-shaped glass bulb designed to eliminate wasted screen area by providing a picture surface in the 4:3 aspect ratio. For 1950, major tube manufacturers indicate that metal coned tubes in various sizes up to 19-in. will be used primarily during the first half of the year with rectangular glass designs gaining increasing prominence as the year draws to a close.

There is also considerable talk about increasing the size of metal-coned direct-view tubes from the current 19-in. to 23-in., (and unconfirmed rumors of 36-in.) and while such a size is entirely feasible with current production technics, applicationwise its use is questionable because of the unwieldy cabinet dimensions that would be required. Larger direct-view tube sizes can be advantageously employed in console type instruments using a mirror to reflect the image to the viewer, but here again competition becomes a factor, since new developments for increased picture brightness, larger viewing angles and reduced costs are also promised by the purveyors of projection type receivers.

METAL-TUBE PRODUCTION



Glass necks of 16-in TV tubes are sealed to metal cones by this machine in General Electric's cathode ray tube plant in Syracuse

CIRCUITS

REDUCING UNIT COSTS—Attention to special TV receiving tube designs that reduce unit costs is much in evidence for the coming months. Most of the activity is centering around the horizontal output and high-voltage flyback circuits where previously comparatively expensive tube types such as the 6BG6G, 1B3/8016, and the 5V4G had been employed. Accentuation, aside from cost, is also toward the miniature tube types in the interests of chassis space economy. Sub-miniature tubes, although applicable for some purposes in television circuits, are still not making inroads because of their relatively high manufacturing costs, and because they are difficult to handle on set assembly lines.

In the radio field, portable battery-operated receivers will be undergoing some radical design changes soon through the development of a new line of 10-drain miniature type tubes. Use of these tubes that require only 50% of the filament current of types presently employed, promise longer battery life or smaller instrument designs.

Disc Recording System

Solutions of many problems to bring about a fidelity range

WHILE it may not be difficult to record frequencies up to say 20 KC on a modern record, there is no single magic expedient by which such a record may be considered in the high fidelity category. The development of a 20-KC recording system recently demonstrated required many factors. Since this demonstration at the recent Audio Fair of the Audio Engineering Society was widely considered as approaching the long sought-for standards of true fidelity, a survey of the details of the system may be of interest. Basically the development was centered around the most critical problems of recording —producing the record on a disc.

The first requirement of such a system, a good microphone, was settled by using a miniature type of condenser microphone, which was found adequate for picking up the highest frequencies needed. While no "perfect" microphone exists whose frequency response is flat up to this point, only a nominal amount of correction was found to be needed to make it an ideal pickup unit.

The amplifier system used with this microphone was unique because the application of a special feedback system was found an indispensable link in achieving full dynamic range and high frequency registration, and still maintaining distortion-free grooves. With feedback cutters of the later type (Fig. 1), any impending distortion in the movement of the engraving stylus is corrected automatically. This complete technic of feedback control of recording amplitudes, the recent development of Emory Cook, of the Cook Laboratories, Floral Park, L. I., includes a number of important details. This feedback amplifier is shown in Fig. 2.

The system is basically concerned with maintaining a highly linear output vs input characteristic over a range of from 40 db below, to 12 db over signal level. The minimum requirement for components in any broadcast type equipment calls for establishing a 10-12 db margin of safety between operating levels and overload. The feedback recording system achieves this, and unlike other recording systems (tape or disc) permits the taking of all measurement data at the full operating level or higher.

Problem of Over-Cutting

Having then obtained a recording system capable of carrying over the normal transient +12 db program peaks to a record groove, a problem immediately arose in the form of transient over-cutting. Over-cutting in disc recording occurs in either one of two ways. First, adjacent grooves may have such high *amplitudes* of excursion as to meet and overlap. This condition has been found to be caused almost entirely by program content below 350 cycles. Second, the angle of lateral displacement of a groove excursion may be too abrupt to permit a playback point to follow it. The latter situation has been found to be caused almost entirely by program content in the range above 2,000 cycles in frequency.

This unusual condition led to the development by Cook of what is called the Quality-Control method of recording. It was shown that this was an indispensable part of the system demonstrated to the Audio Engineers. Briefly, the plan is to divide the signal from the microphone into three parts with filters, according to frequency range. The medium frequencies, roughly those between 350 and 2000 cycles, (which are, by the way, the most important for producing the dynamic range) are not modified as is done to those ranges below and above these frequencies. The dividing network filters are not sharp, having roughly a 6 db per octave separation rate, so that no noticeable change occurs at frequencies near the transition points.

Lower frequencies pass through a volume limiting amplifier whose gain characteristics are altered by a signal proportional to the momentary amplitude of excursion, full low frequency range being permitted if the program is not too loud, so that groove walls can never be broken down. Similarly the high frequencies produce low *amplitude displacements* but large *excursion angles,* since each cycle of the high frequency signal occupies an extremely short space along the groove. A given displacement amplitude for such a cycle may repre-

Fig. 2: In this amplifier, high output impedance of the 807 tubes is intensified by current feedback in one stabilizing loop

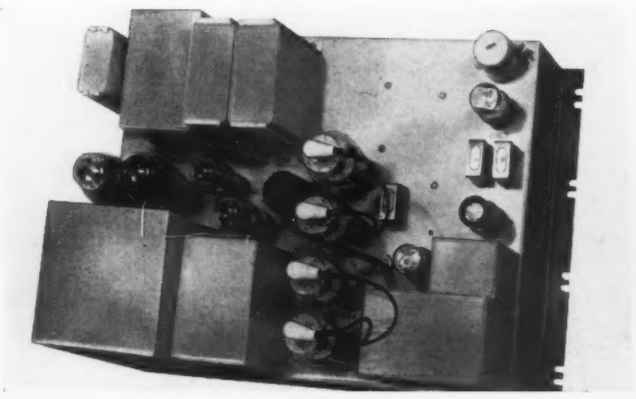
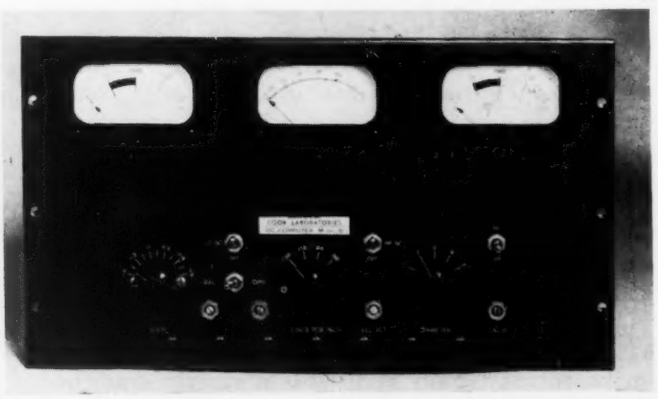


Fig. 3: Control Panel of Q-C automatic "Computer" system whereby a larger dynamic range is obtained without groove distortion



Developments

of over 20 KC described

sent a large excursion angle. In the usual system this effect causes the stylus to be thrown violently from side to side and abnormal tracing distortion and wear on the groove results.

Therefore the high frequency limiting amplifier is also under special control. This limiting is essentially proportional to the rate of change of the voltage producing each cycle being recorded. The limiting factor is also modified by a factor which depends on the RPM and momentary diameter of the groove where the recording is being made at that instant. A general layout of these limiting controls is shown in the block diagram in Fig. 4.

The limiting that can be applied to the excursion angle depends on several factors: the recording media, whether or not a master or an instantaneous playback record is wanted, and other factors. Therefore the extent of limiting was altered to fit the case.

The low frequency amplifier has self-incorporated limiting controlled by a circuit which takes note of stylus amplitude (which is a function of amplifier output) when that amplitude exceeds a certain predetermined value.

Actually this limiting rarely takes place in the usual recording, only during unusually loud passages. The low and high frequency portions of the program signal are thus not necessarily limited at the same time, and the cramping which usually occurs when wide dynamic range recording is handled, is not evident. The control systems whereby each part of the system is separately handled is shown in Fig. 3.

We have now reached another critical stage of the problem, the groove and stylus characteristics. At this point in the system several changes from present normal practice were made. First a V shaped groove was cut as distinguished from the U shape commonly used, the outcome of a research program on stylus contour improvements by Isabel Capps of the Frank L. Capps & Co., New York. It was shown that in the microscopic dimensions of the groove the recording stylus must shape the groove and accurately engrave the music in it. In order to function freely for microgroove recording, the stylus shape and size must be microscopically controlled. In Fig. 5 views of two groove shapes are given.

Fig. 1: The cutter of the 3-B system. It requires four leads (in addition to the driving circuit) to connect the two balanced feedback windings to the amplifier

Stylus with Multiple Facets

The "V-groove III" lacquer recording stylus is of the anti-noise modulation type. This means that it is furnished with multiple facets behind the cutting edge enabling it to burnish the groove walls regardless of the steepness of the lateral wavefront of the groove. While the importance of burnishing has been described before,* further improvements along this line have been accomplished. The outstanding characteristics of the new stylus are three burnishing facets each 0.1 mil wide and, as the name implies, a V shaped contour. In Fig. 6 a photograph of the cutting edge of this stylus is shown with a cross sectional view near the tip.

The advantage of this configuration is a marked reduction of load on the cutting head. The V shape reduces the load of shearing action, while the small burnishing facets, affording each other clearance, reduce the load in the lateral movement. The result of this load reduction is a fuller registration of the original signal both in intensity and frequency.

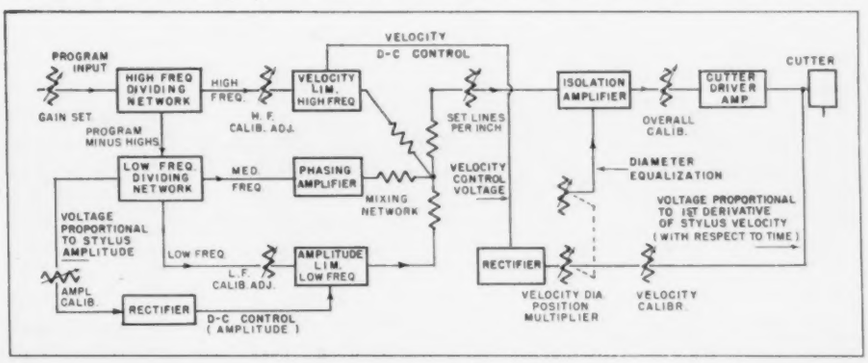
Another advantage contributed by the triple burnishing facets is absence of modulated noise which usually appears as a buzz on top of bright brass passages, or break-up on crescendo passages. In fact distortion is so greatly reduced, the dubs from originals recorded with the V-groove III, played back with a 1.0 mil stylus and re-recorded with a V-groove III, can scarcely be recognized as copies.

As shown in Fig. 7 further advantage lies in the fact that 78 RPM work at standard depth can be played back with either a 1.0 mil

(*Continued on page* 54)

*Electronic Industries, Nov. 1946, page 65.

Fig. 4: The C-C recording system handles the various distortion producing factors separately



Mixing Local and

Simple adaptation of popular receiver synchronizing circuit solves problem of

By W. E. WELLS & J. M. WEAVER
Television Engineering Dept., National Broadcasting Co., Washington, D. C.

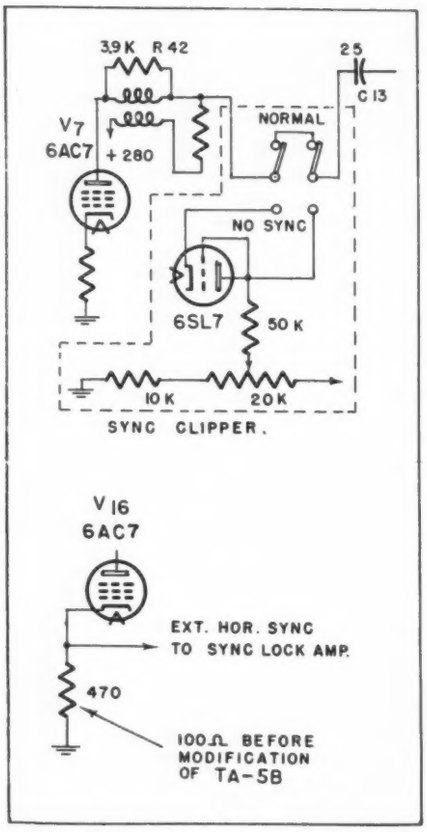


Fig. 1: Modifications to stabilizing amplifier to permit removal of remote sync signals prior to remixing with locally generated sync.

THE Sync Lock Amplifier is designed to lock a local Sync Generator in coincidence with a remote Sync Generator and thus render less objectionable the attendant loss of synchronizing signal at receivers when switches are made between two Sync Generators. It is usual practice to go to a dark screen before the switch is made and to fade up from a dark screen after the switch is completed. This allows time for synchronizing circuits in the receiver to lock in on the synchronizing signal transmitted after the switch and before a picture reappears on the screen, and hence the resultant disturbance of the image due to momentary loss of the synchronizing signal is less noticeable.

As an additional aid in bridging this gap in synchronizing signal continuity, it is good practice to have the 60 cycle components of the synchronizing signals involved phased for approximate coincidence.

If complete time coincidence between the two signals (local and remote) could be maintained, it would be possible to preserve continuity of the transmitted synchronizing signal and thereby eliminate the necessity of going to a dark screen during switching. From the standpoint of smooth program presentation, this is of importance because it is frequently necessary to switch between the local and remote pickups several times in the course of one program, particularly when presenting commercial announcements. In addition, if the local synchronizing signal is transmitted continuously on either the local or remote picture signal (this requires processing the remote signal to remove its synchronizing pulses and adding the local synchronizing signal, see schematic sync clipper, Fig. 1) the receivers are fed a relatively more noise-free synchronizing signal.

Also made available between the local and remote signals are lap dissolves, super-impositions and all other processes normally available between local cameras or studios.

Complete coincidence is required between the local and remote signal to achieve the above benefits and coincidence must therefore be on a line, field and frame basis. This means that even fields must coincide with even fields, etc., and in the final analysis that each line of the 525 lines in a frame of one signal must coincide with its counterpart in the other signal. This complete matching is required before the local synchronizing signal can be used on the incoming signal and comply with FCC standards of transmission.

When the required complete coincidence is obtained, the lock applied to maintain the coincidence must be quite rigid. Any hunting permitted by the lock would: first, render impossible the use of local synchronizing signal on the remote picture signal and, therefore, continuity of synchronizing signal transmission; and, second, render ineffective the use of superimpositions and lap dissolves.

Circuits

In the operation of the sync lock amplifier two input signals are required, one for locking in the oscillator,—see block diagram, the other for the sync mixer for alignment of the local and remote signals.

The remote horizontal sync is applied to grid pin 4 of the 6SN7 sync amplifier (V-5). The signal is amplified further through the second half of the 6SN7 and applied to terminal "E" on the discriminator transformer to lock the oscillator to 31,500 cps.

The other input singal required is local sync and this is applied to one half of a 6SN7 (V-6). The other half of the tube is driven from the cathode of V-5 thus applying remote sync. The two signals are mixed and applied to the output receptacle from the common cathode load.

The oscillator is an extremely stable Hartley circuit operating at a frequency of 31,500 cps. The primary of T-1 is the oscillator coil. This coil is closely coupled to the secondary winding and thus feeds a sine wave voltage to V-1. The frequency of the oscillator is controlled by a slug from the front panel.

The sync discriminator V-1 is a 6AL5 dual diode in a circuit which produces a dc output voltage proportional to the phase displacement between two input voltages. The

Remote Television Signals

fading composite video signals from sources controlled by different sync generators

sine wave voltages applied to the plates of V-1 are equal in amplitude and opposite in phase. The external sync pulse is applied to the center tap of T-1. The external sync pulses thus appear in phase and of equal amplitude on the diode plates. When the pulse and sine wave are properly phased both diodes will produce equal voltages across their load resistances. However, these voltages are of opposing polarity and therefore the sum of the voltages across these two load resistors will be zero. If the phase of the pulse changes with respect to the sine wave one diode will produce more voltage across its load resistance than the other. Thus the voltage across the two will be positive. If the reverse condition exists, the voltage will be negative. It is obvious that the output of the discriminator can swing from positive through zero to negative dependent upon the phase relation of the synchronizing signal and the oscillator. The dc output is applied to the grid of V-2.

The oscillator control tube V-2 is a 6AC7 connected as a reactance tube across the oscillator coil. A change in the dc output of the discriminator produces a change in Gm of V-2 which in turn changes the frequency of the oscillator. If the phase of the oscillator shifts with respect to the synchronizing pulse, the corresponding change in dc from the discriminator brings the oscillator back into correct phase.

The input to the 31,500 cps amplifier is transformer coupled from the plate of the oscillator tube. Both primary and secondary of T2 are slug tuned to 31,500 cps. The output

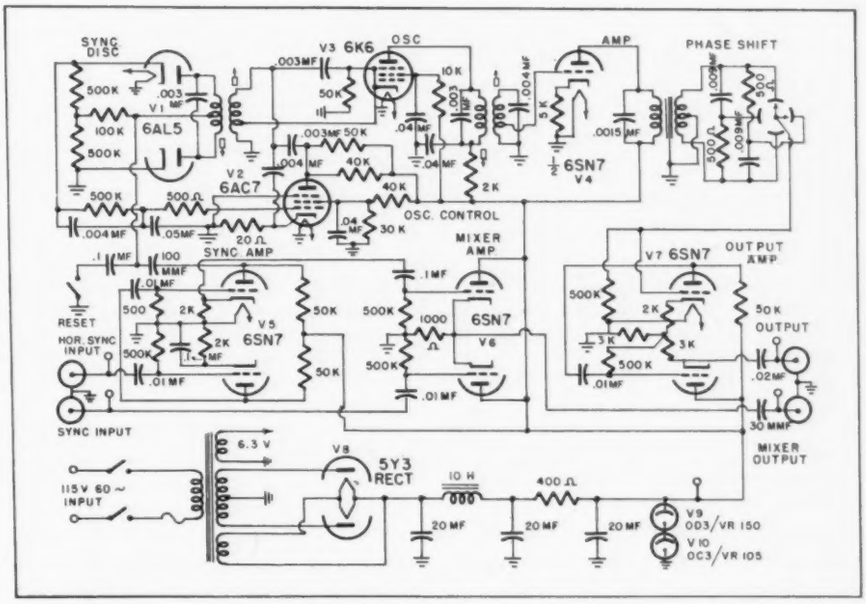


Fig. 2: Circuit diagram emphasizes lack of complex or critical components. The only part which is not completely standard is the special four stator phasing condenser.

of this amplifier is transformer coupled to the phase shift circuit. The primary of T3 is fixed tuned to 31,500 cps.

The phase shift circuit consists of a special four stator, two rotor condenser. The 31,500 cps sine wave is applied to each stator 90° out of phase, thus resulting in 360° phase shift necessary for complete time coincidence between the two sync generators.

The output amplifier consists of one stage of amplification and a cathode follower output using a 6SN7 (V-7) while the power supply is a typical full wave rectifier, 5Y3GT (V-8), whose output voltage of 255 v. is regulated by two voltage regulating tubes.

Complete coincidence is required between the local and remote signals and must be on a line, field and frame basis. With the equipment in an operating condition and all cables connected to their respective receptacles the following steps are necessary for complete coincidence of the two signals.

(1.) Apply a remote sync signal of approximately 2.5 v to the input master horizontal sync input. One method of obtaining this signal is from the cathode of V-6 in the TA-5B stabilizing amplifier.

(2.) Check the output of the sync lock amplifier with a 'scope to see that the oscillator is "locked"

Fig. 3: Rear view of chassis; the phasing condenser is in the center

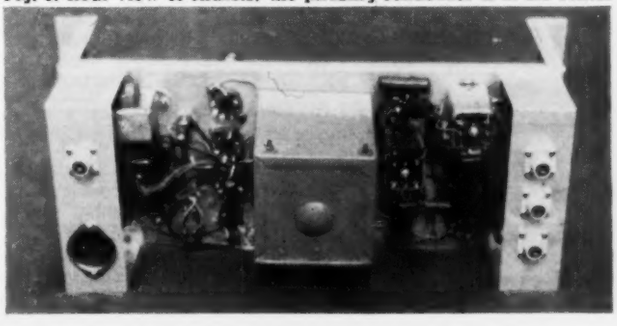
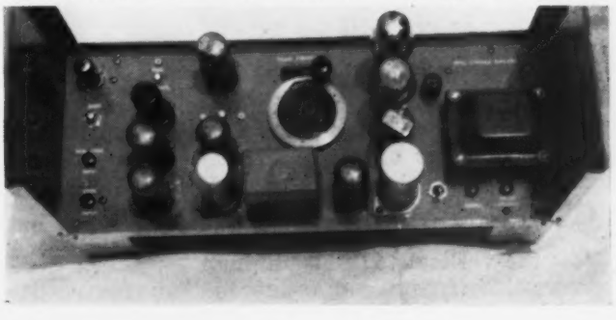


Fig. 4: Front of unit. Note reset button at upper extreme left



MIXING TV SIGNALS (Continued)

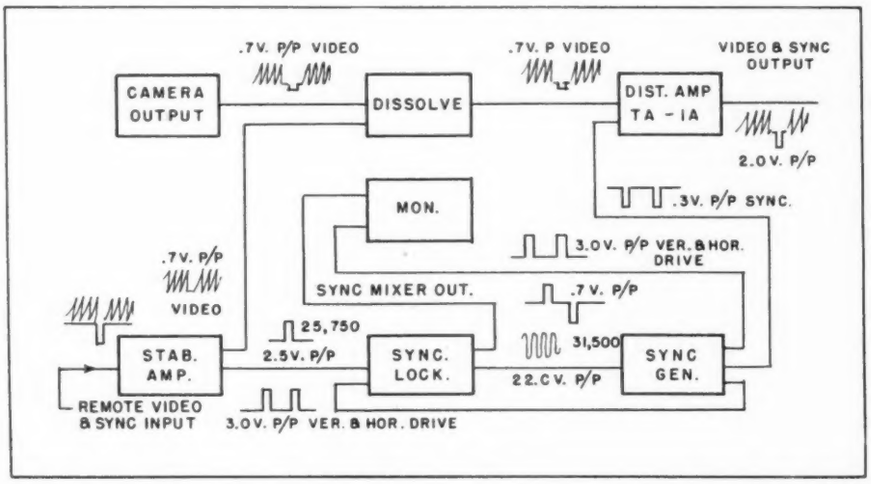


Fig. 5: Block diagram showing typical circuit arrangement and waveforms at individual units. In the case of a remote pickup all the equipment would be located at the master control installation. The composite signal containing video and sync arrives via cable or microwave link. Sync and video are separated in the stabilizing amplifier.

in. Apply the output to the Vertical input of the 'scope and the horizontal sync input to the Horizontal External position of the 'scope. By pressing the RESET push button the oscillator will no longer be locked in but will be "free running".

(3.) Check the output of the sync mixer by applying local sync of approximately 3.0 v. to the input receptacle marked sync input. Note that one sync is positive, the other negative.

(4.) After the above checks have been made and the equipment found to be operating normally proceed to lock the local sync generator with the remote signal.

(5.) Set the frequency control switch of the sync generator TG-IA to the external position. Apply the output of the sync lock amplifier to the external position of the sync generator.

(6.) Apply the output of the sync mixer to the video input of a monitor driven with local sync, or vertical and horizontal drive pulses.

(7.) Note on the monitor the horizontal and vertical phasing between the local and remote signals. If the horizontal is out of phase rotate the phase shift condenser to bring them in phase. If the vertical is out of phase press the RESET push button for an approximate setting of vertical phase and rotate the phase shift control until the first equalizing pulses of both the local and remote signal are in phase. If even versus odd fields line up press the RESET push button again and allow the vertical to "roll" through one vertical frame and rotate the phase shift control for the final alignment. A pulse cross monitor is also very useful for alignment of the two signals. The local sync input to the mixer should be negative when using pulse cross indication. The pulse widths may also be compared with a known standard.

It must be remembered that any loss of incoming signal from a remote pickup will require quick resetting of the frequency control switch to 60 cps or crystal, before trying to use the local sync generator. It is suggested that the external position on the sync generator be wired to an extra common pole with all positions grounded except in the external position. This is necessary to prevent sync cross-over.

Only two components are critical in the equipment, namely in the phase shift circuit. If either of the 560 ohm resistors or .009 condensers are replaced it is recommended that they be measured for ±1% accuracy.

Input and Output Requirements

(1.) Remote sync, positive polarity, approximately 2.5 volts p/p.

(2.) Local sync, positive polarity, approximately 3.0 volts p/p.

(3.) Power Input 115 volts, 60 cps.

(4.) Sync Lock output, 45 volts p/p 31,500 cps sine wave.

(2.) Sync Mixer output, (No load) 1.0 volt p/p positive and negative sync pulses.

The Sync Lock Oscillator circuit is the same as used in the RCA television receiver 630-TS except for a few minor changes. This oscil-

(*Continued on page* 51)

Bell Labs Engineers Recall How Name For Magazine Was Proposed In 1929

Further evidence blasting the erroneous claim by McGraw-Hill that "Back in 1930 McGraw-Hill coined the word electronics," (See November, 1949 issue of Electronics, page 63) is now supplied by outstanding radio and engineering figures.

Also direct testimony that a Bell Laboratories' engineer, John Mills, in 1929 actually suggested the term for U.S. use, as cited by M. Clements and O. H. Caldwell who adopted the term as a title for the new magazine being developed during the Fall of 1929, is contained in the following interesting statement by the president of the Bell Telephone Laboratories:

Dr. Buckley Traces Bell Connections

Dear Dr. Caldwell:

We have been interested in your letter concerning the origin in this country of the word "electronics".

Unfortunately Mr. John Mills not only had retired from the Laboratories some years ago, but has actually passed away, as perhaps you know. This leaves us with no recourse to him.

One of his associates, R. K. Honaman, recalls Mills' having told him that he had suggested the word "electronics" for this art, but he does not recall having learned any of the details or circumstances. A cursory search hereabouts and of the British literature has failed to reveal evidence of its use earlier than 1930.

However, in the German literature the corresponding German word of "Elektronik" was used as early as 1905 in the sense of its being the science of the electron in relation to the science of radioactivity. You will see the name of an annual publication ("Yearbook of Radioactivity and Electronics") under that date, in the accompanying interesting chronology that Mr. Lloyd Espenschied has written under the title of "From 'Electricity' to 'Electronics', a Tracing of the Words".

Also you will see its use again in 1914 in the announcement of an International Congress that was to have been held in Vienna in 1915 on the subject of radioactivity and electronics.

Under these circumstances it seems to us likely that the word would have crept into the English literature by 1929, as you say Mr. Mills had mentioned, but we simply have been unable to spot it in a cursory search.

O. E. Buckley,
President

M. B. Long Heard Mills Propose Title

M. B. Long of the Bell Laboratories was present in John Mills' office that afternoon in September, 1929, when Mills suggested the word "electronics" to replace "Electrons" as an appropriate title for the new magazine which

(*Continued on page* 53)

Design Charts for Transmission Line Matching Systems

By RUSSELL L. LINTON, JR., Research Engineer, Antenna Laboratory, Univ. of California*

IN the design of extremely wide-band antennas — frequency ranges from three to one to ten to one — many compensation technics[1] are available to the radio engineer. For example, the folded dipole or monopole may be used to double the number of resonances within a given frequency range without increasing the physical size of the antenna to any great extent. As is well known, however, such antennas present a general impedance level much higher than that of any widely used coaxial transmission line.[2] To satisfy the overall objective of presenting a reasonable impedance termination to the 50 to 70 ohm transmission line, therefore, some matching scheme is required.

The exponentially tapered transmission line immediately suggests itself. However, tapered coaxial transmission lines are not standard production items; and simulation of any exponential taper, with many standard sections of line, would prove more economical. It was decided to use equilength sections of line, N in number.

Let the characteristic impedance of the nth section be Z_n. (Fig. 1) The standard transmission line impedance is Z_o; the load impedance to be matched is Z_{N+1}. The property of the exponential taper is expressed by the equation: $Z_n = Z_o\varepsilon^{kn}$. (1)

Taking the natural logarithm of both sides:

$$\log Z_n - \log Z_o = kn \quad (2)$$

But at $n = N+1$ (the end of the Nth section) $Z_n = Z_{N+1}$:

$$\log Z_{N+1} - \log Z_o = k(N+1) \quad (3)$$

Solving (3) for k and substituting into (2) yields:

$$\log Z_n - \log Z_o = (n/N+1)(\log Z_{N+1} - \log Z_o) \quad (4)$$

Hence, on the log-log plot of Z_n vs. Z_{N+1} (Fig. 1), the curves of (4) are straight lines of positive slope equal to $n/(N+1)$ and with their point of intersection displaced from the origin to $\log Z_{N+1} = \log Z_o$ and $\log Z_n = \log Z_o$. Therefore, the intersection point will always lie on the $Z_n = Z_{N+1}$ line of unity slope, through the origin, and will be determined by Z_o. At that point both Z_n and Z_{N+1} will equal Z_o.

The slopes of the following sets of curves are readily calculated:

Slope = n/(N+1)

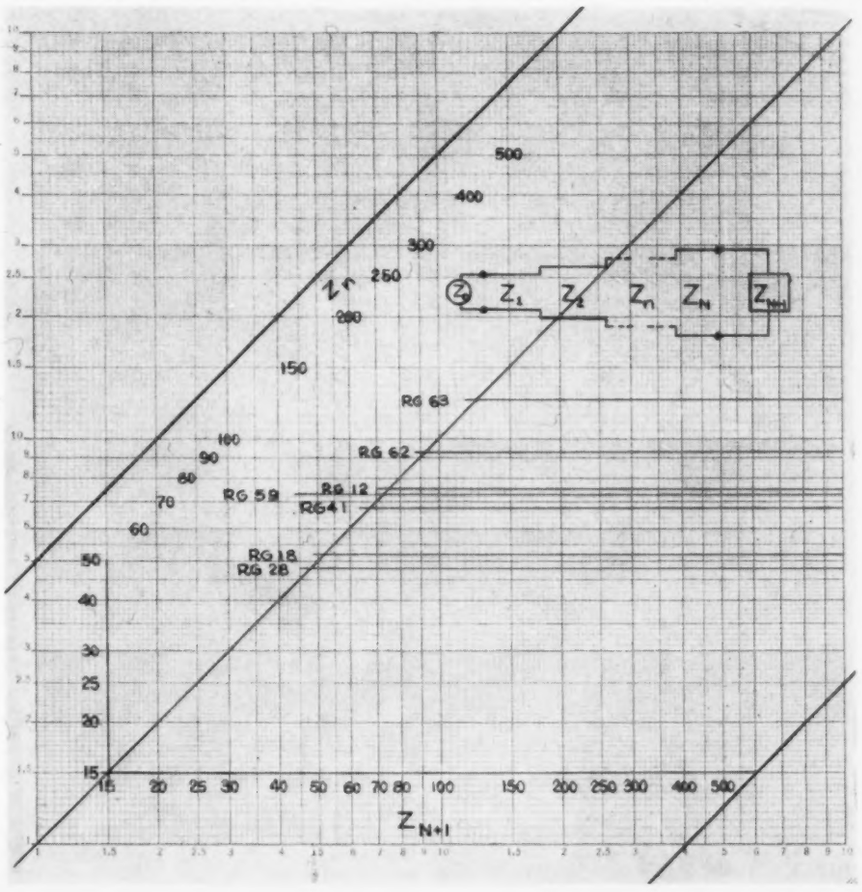
N	n=1	n=2	n=3	n=4	n=5
1	1/2				
2	1/3	2/3			
3	1/4	1/2	3/4		
4	1/5	2/5	3/5	4/5	
5	1/6	1/3	1/2	2/3	5/6

The above table can be extended without limit.

Figures 2a-e are the sets of curves for the values of N and n indicated. The unity slope line is the one labeled with the value of N. This line is to be superimposed on the line of unity slope in Fig. 1. Figures 2 may be reproduced on transparent sheets so that the logarithmic coordinates of Fig. 1 may be utilized. The arrow labeled Z_o is then lined up with the value for the transmission line to be used. The curves then indicate appropriate values of Z_n for any value of Z_{N+1} to be matched.

For greatest convenience, values of Z_n corresponding to standard,

Fig. 1: On the log plot of Z_n vs Z_{N+1} the curves of equation 4 are straight lines of positive slope equal to n/(N + 1) with their point of intersection displaced from the origin



*Mr. Linton is now engaged as a Research Engineer at the Dalmo Victor Co. in San Carlos, Calif.

DESIGN CHARTS (Continued)

commercially available cables should be selected. In Fig. 1 some of these values have been drawn in. In using the charts, the proper set from Fig. 2 is placed over Fig. 1. The designer sights along the abscissa corresponding to the load impedance to be matched. The cable impedances intersecting the lines of the transparent sheet nearest to the proper abscissa are noted. These are the best combinations of available cable impedances to be used in N equilength sections.

Illustrative Example:

In Fig. 3 Curve A is the measured impedance locus of a fat folded monopole. The locus centers at a radius of roughly three times the reference of 52 ohms. Using this value of 156 ($=Z_{N+1}$) in conjunction with Fig. 2a superimposed on Fig. 1, the closest available cable impedance is 93 ohms (RG-62/U). Considering the frequency at point 6 on the locus the lowest to attempt to pull in toward the center of the Smith chart, the length of the matching cable is made one quarter wave length at this frequency. Transforming the locus of Curve A through such a length of transmission line did not yield satisfactory results; so the curves of Fig. 2b were used with Fig. 1.

In this case the closest compromise values are 125 ohms and 75 ohms (RG-63/U and RG-12/U). Dividing the total length, a quarter wave length at point 6, equally between the two types of cable, and transforming the locus of Curve A through the matching sections yields a superior impedance locus. The voltage standing wave ratio from midway between points 5 and 6 to just short of point 19 is 3 or less.

Curve B in Fig. 3 was obtained by repeating the above process for N=3. Superimposing Fig. 2c on Fig. 1 yields:

$Z_3 = 125$ ohms (RG-63/U)
$Z_2 = 93$ ohms (RG-62/U)
$Z_1 = 67\frac{1}{2}$ ohms (RG-41/U)

In this case it was decided to lengthen the line in an attempt to bring in point 5. The total length was made a quarter wave length at this frequency and the individual sections made equal in length. Transforming the locus of Curve A through the resulting transmission line yields Curve B. The VSWR is now 2.5 or less from well below point 6 to well above point 19. Actual measurements confirmed Curve B with complete satisfaction.

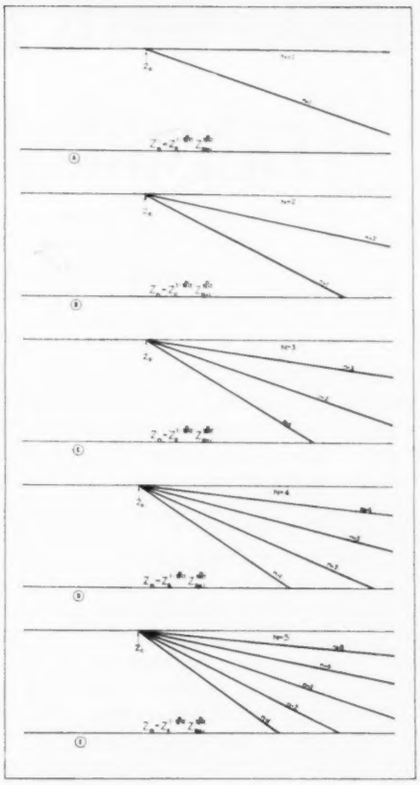
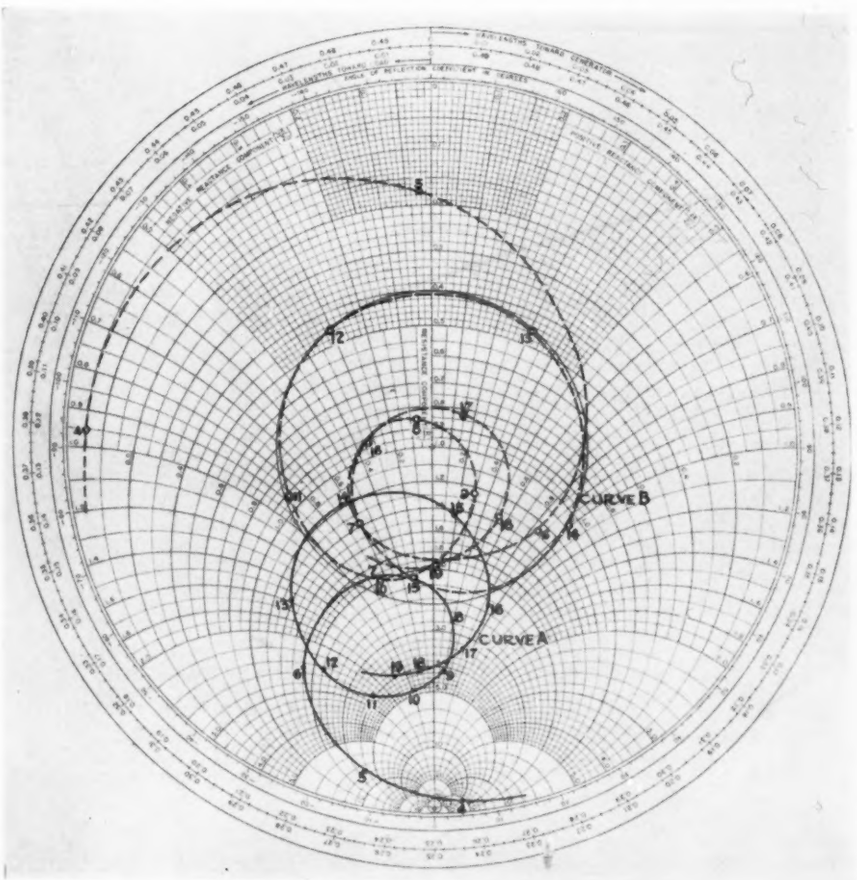


Fig. 2a-e: Sets of curves for values of N and n indicated. Unity slope line is the one labelled with the value of N and is to be superimposed on line of unity slope Fig. 1

Fig. 3: Curve A is measured impedance locus of fat folded monopole. Curve B is for N=3



1. Bennett, Coleman; Meier: "Design of Broad-Band Aircraft Antenna Systems". PROC IRE v33 #10 p671 (Oct '45).
2. Roberts: "Input Impedance of a Folded Dipole". RCA REV v8 #2 (Jun '47). Dalmo Victor Company, San Carlos, California. Formerly Antenna Laboratory, Division of Electrical Engineering, University of California, Berkeley, California. The results described here were made possible through the support extended by the U. S. Navy Bureau of Ships, under contract NObsr-39401.

FCC Hearings on Phonevision

Hearings will be initated by the FCC on January 16th on the subject of Phonevision, a system developed by Zenith Radio Corp., Chicago, in which TV programs are received in the home through the combined use of a TV receiver and telephone lines.

Phonevision concerns the transmission of a standard television signal by a conventional transmitter operating in the VHF (Very High Frequency) television broadcast band. However, the content of the picture transmitted is altered at the transmitter by means of a device which "scrambles" the picture when received by a standard TV receiver. A special apparatus furnished to subscribers of Phonevision service would "unscramble" the picture at the receiver.

New One-Tube Limiter-Discriminator for FM

6BN6 gated beam tubes, aside from combined functions in FM receivers, have many other applications in such circuits as multivibrators, square wave generators, phase measurers, and TV sync clippers

By A. P. HASSE, Receiving Tube Engineering, General Electric Co., Owensboro, Ky.

PART ONE OF TWO PARTS

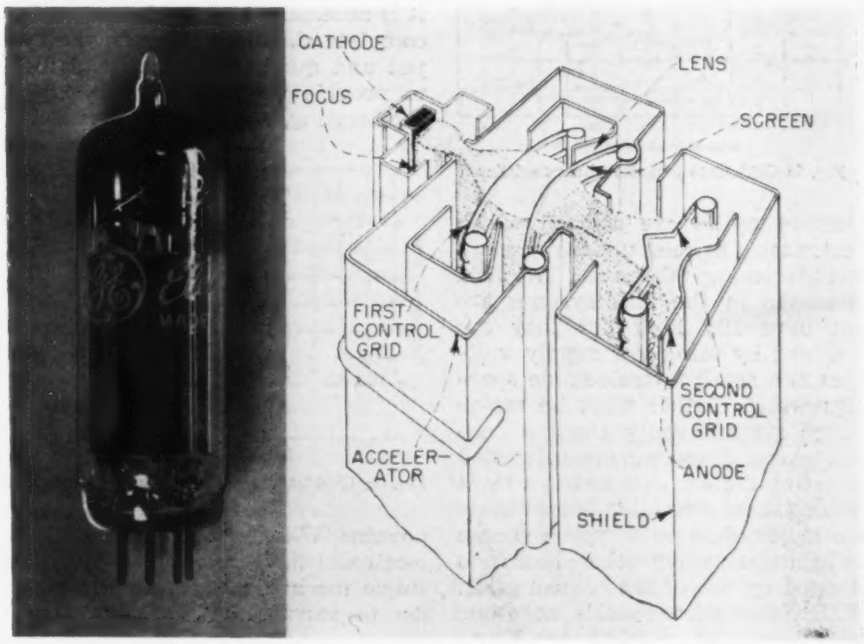


Fig. 1: Left—the exterior appearance of the 6BN6 is the same as a standard tube. Right—enlarged drawing of the electrode arrangement showing sectional construction

IN the wake of the rapid expansion of the FM broadcasting industry and in the light of an ever increasing interest in television, the manufacturers of FM and TV receiving equipment have endeavored to improve the performance of their products and effect economies to encourage sales.

The limiter and discriminator stages of these receivers are ones which are reasonably expensive since a relatively large number of components, and a comparatively expensive and difficult to adjust discriminator transformer are used. Considering the many circuits which have been developed for use as limiter, discriminator or a combination of both, we see that most have features which leave something to be desired from one viewpoint or another.

One general type of discriminator which had not, until recently, found much commercial use is that in which two grids of a tube are operated in a quadrature phase relationship at center frequency and the phase of one grid voltage is caused to vary with respect to the other, about the quadrature point, as the input frequency is varied. In this circuit the resultant plate current, when properly integrated contains the modulation content of the incoming frequency modulated voltage and this intelligence, when developed across some plate load impedance, can be coupled directly into voltage or power amplifier stages. This circuit requires a separate limiter stage and depends upon the grid voltage driving the plate current into saturation in order to obtain the necessary output characteristics.

The initial design of the 6BN6 demonstrated the practical nature of a beam type tube in which a quadrature voltage can be developed by space charge coupling, to yield the discriminator circuit. The inclusion of a highly efficient limiter in the form of an electron beam whose current is defined by placing an apertured slot in the beam at a region of high current density, makes the 6BN6 limiter-discriminator circuit possible.

In developing this tube, the design objective was to have two control elements each with essentially a step function transfer characteristic in order to realize efficient circuit operation at low input levels. Operation at low levels necessitated a design which would yield a well-defined electron beam in order to insure a high input transconductance and further required that the input admittance of the tube be low so that reasonably high gain could be realized in the last IF amplifier of the receiver. Together, these features make possible switching of the plate current between cut-off and its limited value with low input signal to the receiver. Another design objective was that of making a tube which would have essentially constant cathode current regardless of the control electrode potentials. This characteristic would make possible the use of a cathode resistor for developing operating bias voltage.

Unconventional Nature

The 6BN6 as illustrated in Fig. 1 is unique from many standpoints. The electron beam in this tube takes the form of a sheet beam of varying cross section and current density. In addition there are no focusing or intensity controls, as are found in most circuits in which electron beam tubes are used. This requires accurate initial beam forming and focusing and further requires tube processing stability to retain such forming when there is dependence upon cathode emission level and contact potential. Of particular interest is the fact that low voltage

GATED BEAM TUBE (Continued)

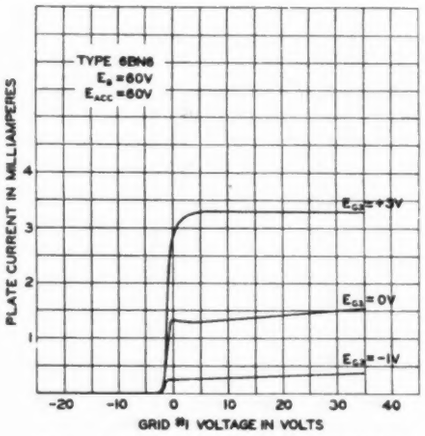


Fig. 2: Grid-plate transfer characteristics

electron optics are utilized which necessitates holding unusually small manufacturing tolerances. The field strengths in the lens systems are not unusually high but they are obtained by using low supply voltages and small interelectrode spacings which further must be maintained symmetrically about a central plane. Since we are interested in gating the electron beam, a third factor for consideration is that there are major changes of space charge distribution when the beam is stopped by one of the control grids. With either of the grids negative, conditions for Barkhausen-Kurtz oscillations are present and we must prevent such osciliations from occurring. Further, space charge coupling within the tube must be unidirectional if the input grid circuit is to remain unaffected by voltages appearing in the quadrature grid circuit.

Among the unusual features of the 6BN6 is that its beam creating accelerator shields the cathode from the electrostatic fields of the control grids. This serves to make the cathode current independent of control electrode potentials. Considering this, we see that with bias for plate current cutoff in the order of 2 volts, the voltage developed across a cathode resistor by accelerator current alone, is easily capable of biasing the tube past the cutoff voltage and that therefor the tube is capable of cutting off its own plate current completely. Since the beam current is of constant amplitude, switching of that current away from the plate circuit by making either of the grids negative causes the current in the accelerator circuit to increase yielding a negative transconductance characteristic to the accelerator electrode. The constant beam current provides limited grid 1 and grid 3 currents which reach saturation at about +2 volts. The magnitude of these limited currents is dependent upon the beam density and the screening area of these electrodes.

Mechanical Considerations

In order to satisfy our objectives, it is necessary to provide unusually complete shielding between the input and quadrature grids and also to provide the necessary focusing, accelerating, and electron lens components. Whenever possible, several electrodes have been combined into single mechanical structures in order to provide the minimum number of parts in the 6BN6 assembly. By making these parts in such manner that mechanical symmetry is obtained about a plane formed by the center of the plate and the vertical axis of the cathode, a symmetrical beam is generated. As mentioned previously, extremely close tolerances are required not only of the individual parts, but also of the whole assembly. Considering that a space between electrodes of 0.040-in. is used to create an electric field intensity of 800 v/cm, a change in position of ±0.002-in. represents a change of about ±40 v/cm in field strength. In the critical area between focus electrode and accelerator a field strength of approximately 1600 v/cm exists with a spacing of only .015-in. The current density along the beam varies downward from 25 ma/cm² so that the relative importance of electronic space charge within the beam varies widely along its path. These two considerations require that high mechanical uniformity be maintained from tube to tube if a uniform product is to be realized. Those components which are of particular importance in this respect are shown in Fig. 1 and are the focusing electrode which surrounds the cathode, the accelerator slot close to the cathode, the lens which surrounds the first grid and the accelerator grid-accelerator region which is just behind the lens. As can be seen, half grids are used to gate the beam and act to shape the return paths of electrons reflected from these elements when they are negative. The lens structure not only forms the beam but also acts as a shie.d to reduce the inter-electrode capacitance from the input grid to the quadrature grid. The last shield structure which surrounds the quadrature grid and plate serves the same function with respect to inter-electrode capacitance and helps to define the effective cathode of this system and confine the paths of reflected electrons to a definite pattern. By preventing the electron beam from striking the side rods of these grid systems, it is possible to limit the grid currents to maximum values in the order of several hundred microamperes.

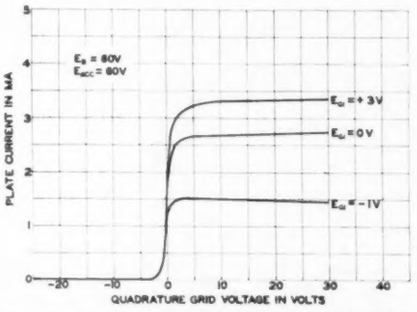


Fig. 3: Quadrature grid-plate characteristics

A factor of some importance regarding the transfer of the beam from the cathode to the plate is that of maintaining low vertical dispersion of the beam. When the beam is passed through the input grid, the increased charge density between grid laterals is such as to cause the beam to disperse vertically after it has passed through them. While the effects of this dispersion cancel at the center of the grid, the end effects are not negligible and can result in some loss of plate current. Since this loss in general appears as additional accelerator current, and it is desired to keep the ratio of accelerator to plate current as low as possible, the 6BN6 has been designed to reduce the effect of such vertical dispersion. In addition, the concentration of space charge between the grid laterals can become high enough to reflect some electrons approaching the grid, resulting in a net loss of plate

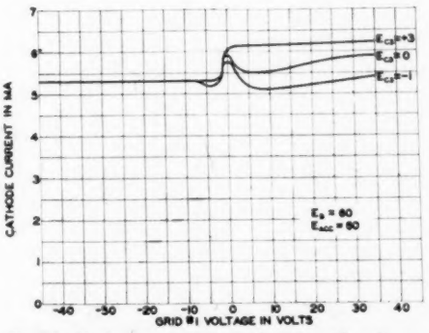


Fig. 4: Cathode current-number 1 grid voltage

current when the grid voltage is low. This property is, of course, useful when cutting off plate current.

In the 6BN6 design, the convergent lens formed by the focus electrode and the accelerator lips and the divergent lens between the apertured slot and the input grid, when that electrode is at low or slightly negative potentials, cause the beam to spread as it approaches the input grid. This action increases the beam area and hence reduces the relative space charge density between grid laterals. The beam is reconverged by passing it through an electrostatic field which is shaped between the lens and the accelerator grid to bring the electrons to a focus in the region in front of the quadrature grid. The quadrature grid is shaped to give an extended depth of grid control so that constant transconductance is obtained despite the movements of the effective cathode of this triode section as the potential of the input grid is changed. The plate structure is formed to obtain constant amplification factor for the triode section.

Tube Characteristics

The extent to which the 6BN6 approaches the step function transfer characteristic can be seen in Fig. 3. For values of quadrature grid voltage in excess of +2 volts, the plate current is essentially constant. For lower grid voltages, the plate current is as indicated on the transfer characteristic curve. Note that this characteristic is essentially linear regardless of the potential of the No. 1 grid for any given value of quadrature grid potential. As has been indicated, two step function characteristics are required for discriminator operation. The quadrature grid-plate transfer characteristic is shown in Fig. 4, and approaches the step function reasonably well. The transconductance of the No. 1 grid is approximately 3,000 micromhos at a plate current of 0.75 milliamperes. The transconductance of the quadrature grid under the same conditions of operation is approximately 1,500 micromhos or a transconductance-to-plate current ratio of approximately 4,000 micromhos per milliampere for the input grid and 2,000 micromhos per milliampere for the quadrature grid. Considering this information, we see that the transfer functions satisfy our objectives reasonably well.

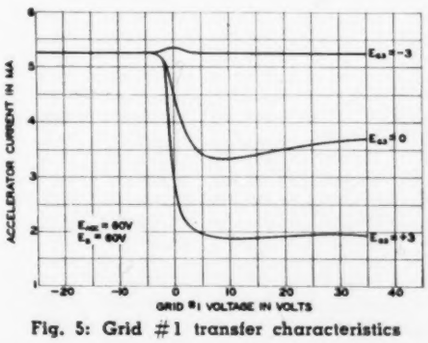


Fig. 5: Grid #1 transfer characteristics

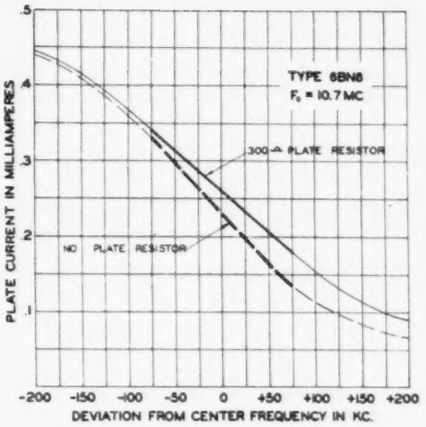


Fig. 6: Plate current plotted against frequency

Fig. 5 shows how cathode current varies with grid 1 and grid 2 potentials. It can be seen that the cathode current is within reason constant regardless of the grid signal levels and consequently a cathode resistor can be used to develop the necessary operating bias. Another transfer characteristic of particular interest is that shown in Fig. 6. Here we see that as the input grid is made more positive, switching the plate current from the cutoff to the limited value, the accelerator current varies from a maximum value downward to a relatively constant value yielding a negative transconductance to the accelerator electrode. The change in accelerator current represents a negative transconductance of 1,500 micromhos. Application of such a characteristic to oscillatory and "flip-flop" circuits is, of course, possible.

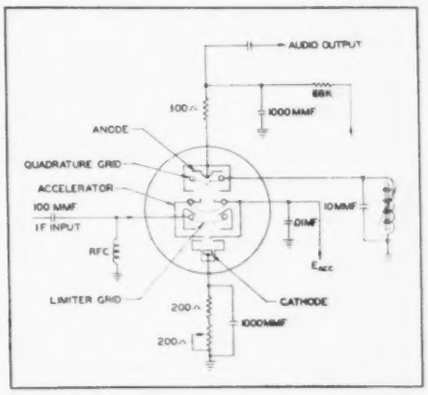


Fig. 7: Schematic circuit of connections to 6BN6 tube. Low cost components are featured

(*Continued on page* 49)

Advantages of a Continuous TV Band

On the front cover we present Tele-Tech's suggested reallocation of the spectrum immediately above the present top television channel, No. 13. At present the government holds the band 216 to 220 MC, but shares it with the mobile aircraft telemetering service and development stations. The 220 to 225 MC band is given over to the amateurs, and from 225 to 328.6 MC the government again rules supreme with some reservations. Until January 1, 1952, at international air gateways 220 to 231 MC will be needed for British radar equipment. And amateurs in these areas can use 235 to 240 MC instead of 220 to 225 MC. The rest of the block is for government stations with "adequate channels to be reserved for civil aviation."

Tele-Tech proposes that the frequencies immediately adjacent to the top end of channel 13 and extending 60 MC to 276 MC be made available for television broadcasters. This would add *ten* VHF 6 MC channels to the twelve existing VHF channels, making a total of 22. Until January 1, 1952 it would be necessary to restrict operations in the 220 to 231 band in international air gateways to avoid interference with airborne British radar.

The plan proposed will refund to the government the 60 MC borrowed by giving up 60 MC from 470 to 530 MC in the UHF television band. The 5 MC amateur band would be restored in the area 276 to 281 MC and the balance of 281 MC to 328.6 MC remains with the government.

If this were done no disturbance would be caused to the present assignments in the band 335.4 to 470 MC. If the 60 MC band is taken from the government some reallocation of telemetering developmental and aircraft frequencies might be required but these could be arranged in individual cases and would not present undue difficulty. For the sake of the television industry in general, the public in the unserved 40% of the country and in the interest of the national well being in maintaining employment in the radio industry careful consideration should be given to this plan.

The convenience to manufacturers in being able to design tuning equipment to cover a continuous band would be very important and the time and expense elements involved by eliminating the need to design new front-ends for UHF would give a much needed impetus to the long range plans of the television industry.

United States and Worldwide

Figures on American receiver production and use, industry and employment totals, as new year opens

THE RADIO-TELEVISION INDUSTRY

Data Covers Year Ended December 31, 1949	Total Investment	Annual Gross Revenue	Number of Employes	Annual Payroll
Radio and TV manufacturers (1200)	$ 85,000,000	$ 785,000,000	110,000	$230,000,000
Radio and TV distributors, dealers, etc.	325,000,000	1,500,000,000	150,000	325,000,000
Broadcasting stations (2897), including talent costs	150,000,000	460,000,000	*23,000	200,000,000
Commercial communication stations	60,000,000	.....	15,000	10,000,000
Listeners' radio and TV sets in use (84,250,000)	3,500,000,000	.....	.....	†680,000,000

* Regular staff — not including part-time employes, artists, etc., who number at least 30,000 more.

† Annual operating expense for listeners' sets, for tube replacements, electricity, servicing, etc.

ANNUAL BILL OF U. S. FOR RADIO-TV

Sales of time by broadcasters, 1949	$ 460,000,000
Talent costs	70,000,000
Electricity, batteries, etc., to operate 84,250,000 radio and TV receivers	300,000,000
10,000,000 home radio receivers, at retail value	500,000,000
2,700,000 television receivers, at retail value	810,000,000
Phonograph records, 225,000,000	202,500,000
Radio repairs and supplies:	
80,000,000 replacement tubes	110,000,000
Radio-TV parts, accessories, etc.	140,000,000
Labor	130,000,000
TOTAL	$2,722,500,000

RADIO SETS IN U. S.; WORLD

	January 1, 1950
United States homes with radios	42,000,000
Secondary sets in above homes	21,000,000
Sets in business places, institutions, etc.	4,000,000
Automobile radios	14,000,000
TV Sets	3,250,000
TOTAL sets in the United States	84,250,000
Total radio sets in rest of world: North America, 5,500,000; South America, 5,000,000; Europe, 61,500,000; Asia, 10,500,000; Australia, 2,500,000; Africa, —1,500,000	86,000,000
TOTAL sets in world	170,750,000

PRODUCTION OF CIVILIAN RADIO SETS — 1922 TO 1949

	Total Civilian Radio Sets Manufactured		Total Civilian Tubes Manufactured		Automobile Sets Manufactured		Total Radio Reception Equipment	Auto Sets In Use	Homes with Radio Sets	Total Radio Sets in Use in U. S.	At Close of
	Number	Retail Value	Number	Retail Value	Number	Retail Value	Value	Number	Number	Number	
1922	100,000	$ 5,000,000	1,000,000	$ 6,000,000	.....	.....	$ 60,000,000	.....	260,000	400,000	1922
1923	550,000	30,000,000	4,500,000	12,000,000	.....	.....	151,000,000	.....	1,000,000	1,100,000	1923
1924	1,500,000	100,000,000	12,000,000	36,000,000	.....	.....	358,000,000	.....	2,500,000	3,000,000	1924
1925	2,000,000	165,000,000	20,000,000	48,000,000	.....	.....	430,000,000	.....	3,500,000	4,000,000	1925
1926	1,750,000	200,000,000	30,000,000	58,000,000	.....	.....	506,000,000	.....	5,000,000	5,700,000	1926
1927	1,350,000	168,000,000	41,200,000	67,300,000	.....	.....	425,600,000	.....	6,500,000	7,000,000	1927
1928	3,281,000	400,000,000	50,200,000	110,250,000	.....	.....	690,550,000	.....	7,500,000	8,500,000	1928
1929	4,428,000	600,000,000	69,000,000	172,500,000	.....	.....	842,548,000	.....	9,000,000	10,500,000	1929
1930	3,827,800	300,000,000	52,000,000	119,600,000	34,000	$ 3,000,000	496,432,000	.....	12,048,762	13,000,000	1930
1931	3,420,000	225,000,000	53,000,000	69,550,000	108,000	5,940,000	300,000,000	100,000	14,000,000	15,000,000	1931
1932	3,000,000	140,000,000	44,300,000	48,730,000	143,000	7,150,000	200,000,000	250,000	16,809,562	18,000,000	1932
1933	3,806,000	180,500,000	59,000,000	49,000,000	724,000	28,598,000	300,000,000	500,000	20,402,369	22,000,000	1933
1934	4,084,000	214,500,000	58,000,000	36,600,000	780,000	28,000,000	350,000,000	1,250,000	21,456,000	26,000,000	1934
1935	6,026,800	330,192,480	71,000,000	50,000,000	1,125,000	54,362,500	370,000,000	2,000,000	22,869,000	30,500,000	1935
1936	8,248,000	450,000,000	98,000,000	69,000,000	1,412,000	69,188,000	500,000,000	3,500,000	24,600,000	33,000,000	1936
1937	8,064,780	450,000,000	91,000,000	85,000,000	1,750,000	87,500,000	537,000,000	5,000,000	26,666,500	37,600,000	1937
1938	6,000,000	210,000,000	75,000,000	93,000,000	800,000	32,000,000	350,000,000	6,000,000	28,000,000	40,800,000	1938
1939	10,500,000	354,000,000	91,000,000	114,000,000	1,200,000	48,000,000	375,000,000	6,500,000	28,700,000	45,300,000	1939
1940	11,800,000	450,000,000	115,000,000	115,000,000	1,700,000	60,000,000	584,000,000	7,500,000	29,200,000	51,000,000	1940
1941	13,000,000	460,000,000	130,000,000	143,000,000	2,000,000	70,000,000	610,000,000	8,750,000	29,700,000	56,000,000	1941
1942	4,400,000	154,000,000	87,700,000	94,000,000	350,000	12,250,000	360,000,000	9,000,000	30,800,000	59,340,000	1942
1943	.....	.....	17,000,000	19,000,000	.....	.....	75,000,000	8,000,000	32,000,000	58,000,000	1943
1944	.....	.....	22,000,000	25,000,000	.....	.....	85,000,000	7,000,000	33,000,000	57,000,000	1944
1945	500,000	20,000,000	30,000,000	35,000,000	.....	.....	105,000,000	6,000,000	34,000,000	56,000,000	1945
1946	14,000,000	700,000,000	190,000,000	200,000,000	1,200,000	72,000,000	900,000,000	7,000,000	35,000,000	60,000,000	1946
1947	17,000,000	800,000,000	220,000,000	260,000,000	2,500,000	150,000,000	1,100,000,000	9,000,000	37,000,000	66,000,000	1947
1948	14,000,000	600,000,000	200,000,000	230,000,000	2,800,000	200,000,000	950,000,000	11,000,000	40,000,000	74,000,000	1948
1949	10,000,000	500,000,000	190,000,000	350,000,000	3,500,000	240,000,000	1,500,000,000	14,000,000	42,000,000	81,000,000	1949

Figures for sets give value with tubes in receivers. In normal years, replacement tubes have run 25% to 40% of total tube production. All figures are at retail values. (Statistics Copyrighted by Caldwell-Clements, Inc.)

Radio-Television Statistics, 1950

Radio sets in use in the countries of the globe
(International figures compiled by Dr. Arno Huth[1])

Rank	Country	Number of sets or loudspeakers: Latest available data	Estimates for January 1950	Remarks
1	United States	61,935,500* 74,000,000 incl. TV sets 3,250,000	84,250,000	*Additional 5,177,100 sets not in working order. (BMB)
2	Great Britain and Northern Ireland	12,017,510*	12,250,000	*incl. 162,150 combined Radio-TV licenses
3	Germany	10,346,373*	11,000,000	*American Zone. 2,539,042 (4/30/49) — British Zone 3,752,578 (8/1/49)—French Zone 623,750 (1/31/49) — Russian Zone 2,600,000 (10/1/48) — Berlin 831,003 (1/1/49)
4	U.S.S.R.	8,000,000*	10,000,000	*Official figures: 5,500,000 licenses up to 40° Long. East. 85% only loudspeakers.
5	France	6,337,193*	8,500,000	*Undeclared sets estimated at 2,000,000
6	Japan	7,592,625*	8,000,000	*Figures given by U. S. Dept. of State: 8,050,000
7	Canada (incl. Newfoundland)	3,192,370*	3,300,000	*Source: Dominion Bureau of Statistics. Other Canadian estimates: 3,106,700 (8/49) and 3,147,600 (10/49). License figures 1948/49: 2,088,764
8	Italy	2,204,580	2,500,000	
9	Czechoslovakia	2,280,017	2,400,000	
10	Sweden	2,069,094	2,150,000	
11	Australia	1,832,816	2,000,000	
12	Netherlands	1,813,454*	1,850,000	*Incl. 523,678 loudspeakers
13	Argentina	1,704,893*	1,850,000	*Census figure. Other sources give 1,350,000 (AIR, 1949); 1,400,000 (U. S. Dept. of Commerce 1/27/48); 1,600,000 (U. S. Dept. of State 1949)
14	Brazil	1,600,000*	1,800,000	*Source: U. S. Dept. of Commerce. Declared sets 800,000 (1948) Other estimates: 800,000 (AIR); 1,200,000 (Guzman); 1,700,000 (U. S. Dept. of State); 2,500,000 (UNESCO).
15	Belgium	1,276,645*	1,350,000	*Incl. 72,341 loudspeakers
16	Austria	1,200,054*	1,300,000	*Ravag 682,010 — Alpenland 219,917 — Rot-Weiss-Rot 205,781 — West 92,346
17	Denmark	1,177,608	1,250,000	
18	Poland	1,054,604*	1,200,000	*Incl. 335,542 loudspeakers
19	Switzerland	989,539*	1,050,000	*Incl. 149,562 loudspeakers
20	Ukraine	900,000*	1,100,000	*Source: U. S. Dept. of Commerce 80-85% of the audience have only loudspeakers
21	Mexico	849,480	900,000	
22	Cuba	700,000*	850,000	*Sources: AIR and UNESCO. Other estimates: 540,000 (1949)
23	China	850,000	750,000*	*Decrease likely, due to destructions and scarcity of replacements
24	Norway	700,000	740,000	
25	Finland	629,907	700,000	
26	Spain	557,794*	900,000?	*Number of sets considerably higher than licenses. Estimates by advertising agency repres. Spanish stations 1,500,000 (1949)
27	Chile	550,000	600,000	
28	Hungary	525,000	560,000	
29	Union of South Africa	497,428	550,000	
30	Colombia	450,000	500,000	
31	New Zealand	434,014	450,000	
32	Korea	374,000	420,000	
33	Portugal	187,385*	400,000?	*Number of undeclared sets estimated at 200,-300,000 bringing total to 390,000 (U. S. Dept. of Commerce) or 500,000 (Administr. Director of Radio Nacional, Lisbon)
34	Uruguay	300,000*	350,000	*Source: AIR and UNESCO. Estimate by U. S. Dept. of State: 230,000 (1949)
35	India	300,000	325,000	
36	Yugoslavia	260,000	300,000	
37	Eire (Ireland)	273,824	290,000	
38	Turkey*	232,475	260,000	*European and Asiatic areas.
39	Rumania	226,000	250,000	
40	Bulgaria	205,000*	210,000	*Incl. 5,000 loudspeakers
41	Egypt	183,000	200,000	
42	Venezuela	175,000	200,000	
43	Algeria	163,877	190,000	
44	Bielorussia	86,000*	180,000	*At least 80 to 85% of the audience have only loudspeakers
45	Peru	150,000	175,000	
46	Bolivia	150,000*	160,000	*Source: UNESCO. Other estimates: 50,000 sets
47	Hawaii	140,000*	150,000	*Source: Pan American B.C. Co.
48	Greece	120,000*	150,000	*High percentage of undeclared sets
49	Puerto Rico	128,900*	140,000	*Figures by WIBS, Puerto Rico. Other estimated: 85,205
50	Israel	104,400	125,000	
51	Dutch East Indies & Indonesia	101,868*	?*	*Figures apply to Dutch East Indies. Estimates for Indonesia 100,000 (1949, U. S. Dept. of State). No reliable estimates possible for 1950 because of recent armed conflicts in this country
52	French Morocco	100,985	120,000	
53	Pakistan	75,000	120,000	
54	Paraguay	80,000*	85,000	*Source: UNESCO. Census 1945: 74,000 sets.
55	Latvia	50,000	75,000*	*Many loudspeakers
56	Iran	60,000	65,000	
57	Panama	47,000	60,000	
58	Tunisia	44,869*	60,000	*Undeclared sets, 56,000
59	Luxemburg	48,944	55,000	
60	Iraq	45,000	50,000	
61	Iceland	41,000	50,000	
62	Malaya and Singapore	38,604*	50,000	*Estimates supplied by British official sources, not including unlicensed sets. Figures given by U. S. Dept. of State 72,000.
63	Estonia	35,000	50,000*	*80% loudspeakers
64	Lithuania	32,600	50,000*	*Many loudspeakers
65	Albania	40,025	45,000	
66	Philippines	35,000	45,000	
67	Siam (Thailand)	36,000	40,000	
68	Ecuador	35,000	40,000	
69	Costa Rica	32,000	40,000	
70	Dominican Republic	29,808	40,000	
71	Guatemala	29,798	40,000	
72	Lebanon	31,000*	35,000	*Source: UNESCO. Estimate by U. S. Dept. of State 22,000 sets (1949)
73	Hong Kong	30,610	32,000	
74	Syria	30,000	32,000	
75	Malta	28,500*	30,000	*Incl. 14,500 loudspeakers.
76	Ceylon	23,000	25,000	
77	Honduras	20,000*	25,000	*Sources: UNESCO and AIR. Figures given by U. S. Dept. of State 7,000 (1949)
78	Lybia	27,000	20,000	*Decrease likely due to wartime destructions.
79	French Indochina	18,000	20,000	

Additional Countries and Set Estimates for 1950

80—Trinidad and Tobago, 18,000; 81—Netherlands West Indies, 16,500; 82—El Salvador, 16,000; 83—Southern Rhodesia, 15,000; 84—Spanish Morocco, 15,000; 85—Kenya, 12,000; 86—Belgian Congo, 12,000; 87—Tanger, 12,000; 88—Burma, 12,000; 89—Jamaica, 12,000; 90—Monaco, 11,000; 91—Canary Islands, 11,000; 92—Nigeria, 10,000; 93—Saudi Arabia, 10,000; 94—Nicaragua, 10,000; 95—Gold Coast, 9,000; 96—Mozambique, 9,000; 97—Eritrea, 9,000; 98—Angola, 8,000; 99—Ethiopia, 8,000; 100—Cyprus, 7,000; 101—British Guiana, 6,500; 102—Afghanistan, 6,500; 103—Madeira, 5,500; 104—Bermuda, 6,000; 105—Mauritius Islands, 5,000; 106—Barbados, 5,000; 107—Dakar (French West Afrika), 4,500; 108—Haiti, 4,000; 109—Curaçao, 4,000; 110—Gibraltar, 2,400; 111—Bahamas, 2,250; 112—Martinique, 2,250; 113—Dutch Surinam, 2,200; 114—New Caledonia, 2,150; 115—Sierra Leone, 1,850; 116—Fiji Islands, 1,700; 117—Tanganyika, 1,200; 118—Brit. Honduras, 1,200; 119—Liberia, 1,200; *Less than 1,000 sets* (or loudspeakers): Guadeloupe, North Borneo, Northern Rhodesia, French Somaliland, St. Vincent, Transjordania, and Uganda.

[1]See also "Status of Broadcasting Overseas" by Dr. Huth, TELE-TECH, January 1947.

For MANUFACTURERS – New

Practical suggestions for increasing production,

Edited by *BERNARD F. OSBAHR*

Packing Delicate Test Instruments

DELICATE communication testing equipment that must be accurate to within one part in 10,000 upon arrival at destination presented a packing and shipping problem that has been successfully solved at the Palo Alto, Calif. plant to the Hewlett-Packard Co.

After considerable experimentation with various types of containers and methods of packing it was discovered that shipping damage was a minimum when the equipment was packed in wirebound boxes designed to absorb the bulk of shipping shocks and jars.

In assembling all-bound packing box, one piece wrap-around "mat" forms four sides. Ends are attached by inserting their wire loops through slots beneath "mat" end cleats

The various test instruments weigh up to 50 pounds and each unit is generally of high value, some worth hundreds of dollars. Shipping room economies result because of the the ease and speed with which wirebound boxes are assembled and packed, their relatively low tare weight, and the small space they require for storage before use.

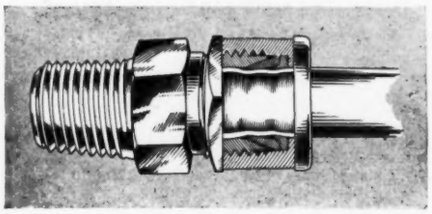
In assembling the box the one-piece wire-bound wrap-around "mat" is folded to form the four sides and the ends are attached by inserting their wire loops through slots beneath end cleats of the "mat". In packing, a bed of excelsior is laid on the bottom of the box, the equipment is wrapped in heavy paper and placed on the excelsior, and then the rest of the box is tightly filled with more excelsior. The cover of the all-bound box is easily closed and fastened by engaging and bending the opposing wire loop fasteners. Assembling the shipping box, wrapping, packing, closing the container and labeling requires six to eight minutes. Over 40,000 shipments from the Palo Alto plant using this method were made with insignificant damage.

* * *

Leak-proof Tube Fittings

SOME of the advantages of the "Swagelok" fittings made by the Crawford Fitting Co., Cleveland, Ohio, are apparent in the accompanying cross-sectional drawing. For example, the tubing is supported rigidly over the entire length of the fitting. Also this new type of fitting provides leak-proof seals at three separate points. Two ferrules and a threaded chuck clamp tightly around a tube with no damage to the tube wall. There is virtually no constriction of the inner wall so that turbulence is held to a minimum. Tests have indicated that the tubing will burst before these fittings develop a leak.

These fittings require no disassembly before use. Neither is it necessary to perform any preparatory steps on the tubing itself. The "Swagelok" is simply fitted onto the



Cross sectional view of new type leak-proof tube fitting which requires no dis-assembly before use and does not involve any preparatory steps to be taken on the tubing itself

end of a tube, given one-and-one-quarter turns and the assembly is ready for service. Another important feature is that the tubing remains stationary throughout the brief and easy tightening operation —no damaging torque or twisting is transmitted to the tube.

"Swagelok" fittings were recently made available in Monel. They are also made in other commonly used alloys, such as brass, aluminum, steel and stainless steel.

* * *

Aligned Connector Contacts

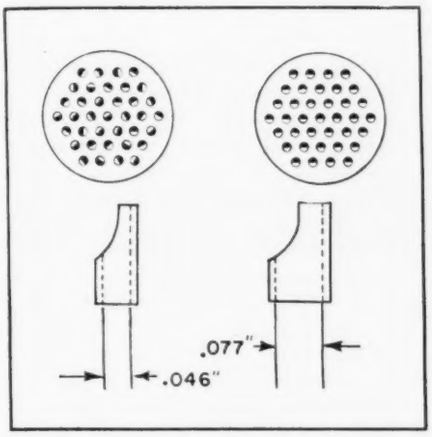
SOLDERING wires to contacts in AN connectors can become a tedious and costly process, especially when the larger connectors with a multiplicity of contacts are used. To facilitate soldering, thus cutting the time and expense involved, Amphenol has made it a practice to assemble AN connectors with the solder pockets all facing in one direction. There is no hunting and aligning of contacts on an Amphenol connector. The contacts all face one way, will not twist or turn and are infinitely easier to solder than when they are free to rotate in the insert.

Illustrated herewith are the two types of inserts with contacts. To the left is the ordinary style showing the helter-skelter manner of placing contacts. On the right is the Amphenol style with all solder pockets fixed and facing in one direction ready for the soldering iron.

Another refinement of Amphenol connectors is the size No. 20 contact. Those who have struggled in an attempt to solder a No. 20 wire

Methods, New Materials, and New Machines.

improving quality and reduced costs



Diagrams showing (left) ordinary style connector insert with contacts and (right) Amphenol style connector where all contacts are aligned and the solder pockets enlarged

to the .046 in. solder pocket in the ordinary No. 20 contact know how exasperating the small cup can be. Amphenol has made its No. 20 contacts with a .077 in. solder pocket to minimize grief on assembly lines and speed up production.

* * *

Cold-welding Non-ferrous Metals

A METHOD of welding metals by pressure at room temperature or cold pressure welding has been developed by the General Electric Company, Ltd., of England. This process, controlled in the United States by the Koldweld Corporation, 10 East 40 St., New York 16, N. Y., can be successfully applied to several types of non-ferrous metal — aluminum, duralumin, cadmium, lead, copper, nickel, zinc, and silver. However, for the present its most important application is for cold welding of aluminum.

The aluminum surfaces to be welded must be entirely free from the film of oxide, which begins to form on aluminum immediately after it is exposed to atmosphere. Although thin by ordinary standards, this film will prevent welding, but it is easily removed by a simple method, such as scratch brushing.

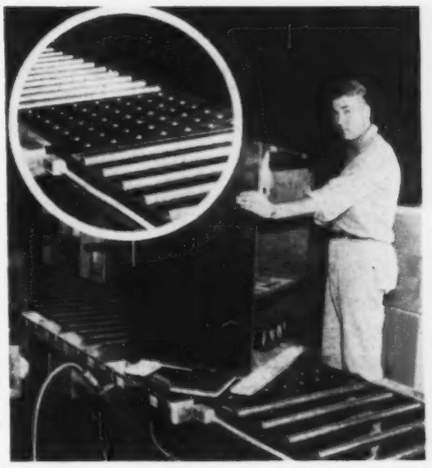
Once removed, the oxide film reforms comparatively slowly, and satisfactory welds can be made several hours later, provided that the cleaned surface has not meanwhile been contaminated by moisture or grease. Even the contamination caused by handling the material will invariably prevent formation of a satisfactory weld.

In the cold pressure process of welding, the metal is made to flow away from the welding point as the tools are brought together. It is perhaps surprising that the rate of application of the pressure does not appear to affect the strength of the weld, and that good welds can be made with tools giving either a slow squeeze or an impact. However, the shape of the tool is most important.

From the runs so far carried out with suitable die materials, there has been very little evidence of die wear. In many applications, however, it will be possible to counteract the effects of such wear by occasionally resetting the die closure.

Three somewhat different technics have been evolved—the straight weld, the ring weld, and the continuous seam weld.

The straight weld can be used for box seams, for sealing tube ends, and for other forms of lapped joints; almost equivalent to butt-welds.



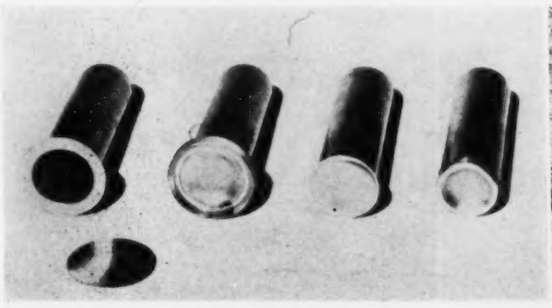
Production of TV receivers at the DuMont plant in E. Paterson, N. J., is facilitated by insertion of ball-plate sections at various points along the roller conveyors. These plates enable a full 360° turn of the cabinet and thus permit operators to work from both sides of the lines in installing chassis, CR tubes, back covers, etc.

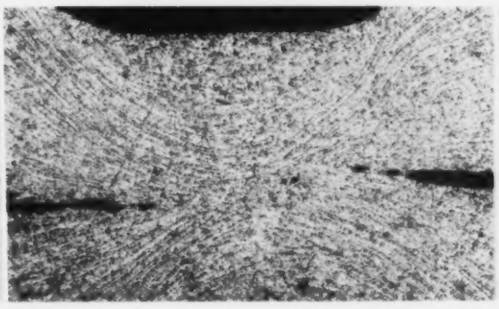
The ring weld can be used for sealing the end of a flanged tube, and several other applications. It may be used for joining a flanged tube to a plate for making hose connections, or two discs may be joined together to form an air pressure cell. Wheels also may be constructed, by taking advantage of the natural flow of the material, to form the shape.

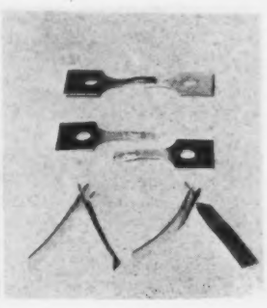
* * *

Readers are invited to contribute their own suggestions which should be short and include photographs or rough skteches. Our usual rates will be paid for material used.

(Left) Hermetically sealed containers that have been formed by the Koldweld process. Steps shown are: flanged tube before welding; after welding; excess metal trimmed off; weld dressed over. (Center) Micro section of typical weld shows lines of flow and absence of weld line. (Right) Tensile test experiments that were made up in 20 s. w. g. half-hard aluminum, with typical tears illustrated below







Practical Filters for

Two-section high-pass m-derived filters prove highly effective

PRESENT television facilities are largely confined to urban areas for economical reasons. Unfortunately, built-up areas where audiences large enough to be profitable exist, are generally saturated with interference — particularly the harmonic radiations from radio services operating at lower carrier frequencies. The net total of all such sources is generally referred to by the public as either "diathermy" or else "amateur" interferences (to the disgust of those operating in these particular fields). The amateurs particularly, whose reputations having been tarred with such adverse publicity, right or wrong, have been concerned with many developments aimed at reducing or eliminating causes for such complaints as are justified.

A simple filter seems to give a notable improvement to reception in troublesome areas. Particular value has been found for a high-pass filter attached to the receiver that effectively cuts out all signals having frequencies below the television band. This report covers the design, construction and use of filters resulting from a study of the problem.

TELEVISION interference filters fall into two separate categories: a simple high-pass filter that can be connected at the antenna posts of the receiver to cut out signals below the TV band, and a low-pass equivalent for amateurs and others connected in the transmitter output circuits to pass band frequencies below TV. Marked improvements in picture quality with these filters have been noted. A unit of the first type must be simple, cheap and easy to install so that its application to the receivers in an area is not handicapped by costs. On the other hand, the low-pass equivalent must be entirely effective, and such matters as complete shielding, highest quality components, etc., are uppermost.

Direct application of well-known filter formulas is made, using two or more "m" and "k" type sections. The components are simple, air spaced coils of a few turns; some small capacitors and the necessary shielded can and terminals. Two general forms take care of most of the high-pass receiver designs: for a 300 ohm twinex lead, and for a 75 ohm coaxial. Factors known are the terminal impedance, cut-off frequency, and, from standard practice, simple circuit configurations that produce a good low frequency attenuation. It is also convenient to be able to use standard values of fixed capacitors—those readily obtainable. The high pass application is based on a two section m—derived filter, having two T type half end sections and a T type intermediate section with a cut-off at 40 MC.

Fig. 1 shows the resulting configurations for (a) a high-pass filter for receivers with balanced input, and (b) a 75 ohm coaxial line input. The commercial (Eldico) versions of the filters (a) and (b) are shown in Figs. 4 and 5. The coils shown can be air wound coils, self supported to reduce their capaci-

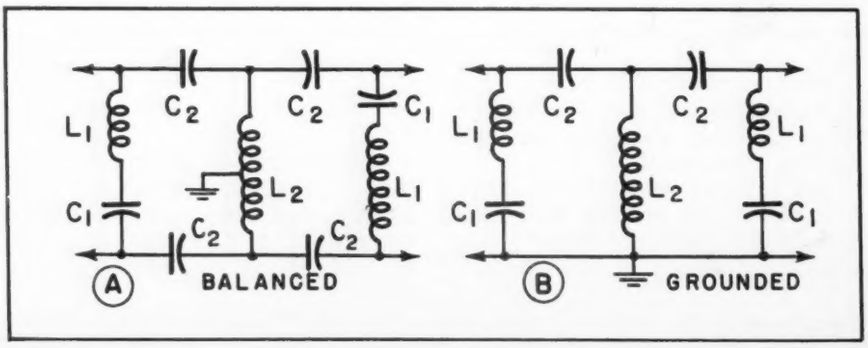
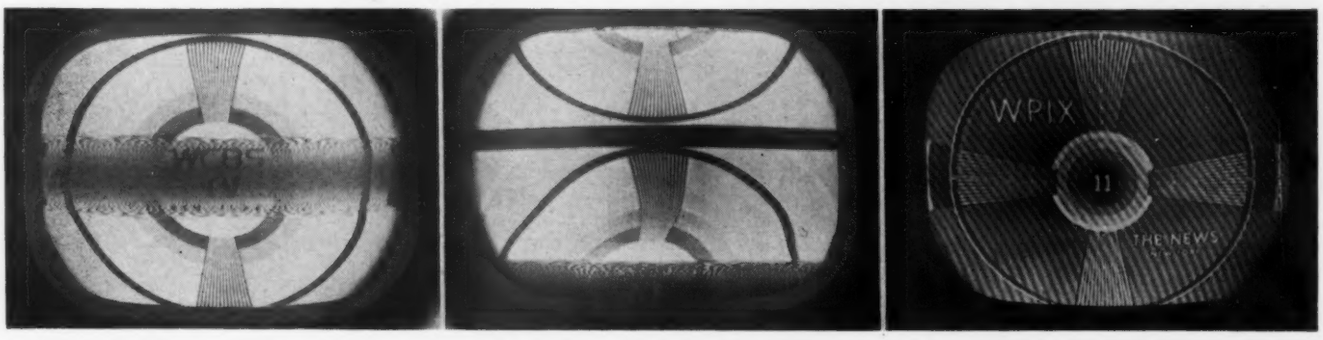


Fig. 1: Basic diagram of balanced line (left) and unbalanced cable filters (right)

Fig. 2: (below) Typical forms of television interference due to signals of low carriers are reduced by high pass filters of type described. (Photos by Sylvania Electric Products



Minimizing TV Interference

as low-cost attachments for existing television receivers

tances, and hung by their leads, or can be spaced wound on forms. No. 20 enameled wire has been found to be satisfactory for coils wound on insulated tubes and #16 bus wire is for self supported coils. The capacitance of all components with respect to the shield should be minimized and equalized.

Excessive coupling between the coils should be avoided. Some designers may prefer to mount the coils with their axes at the well known "magic angle" so common on TRF receivers produced in the "20's". Here an angle of about 50°

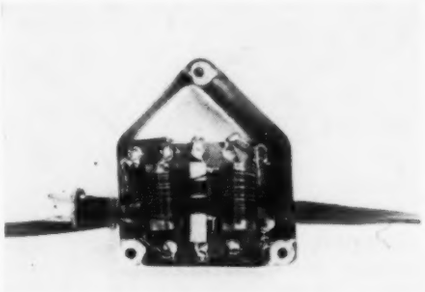


Fig. 4: Practical adaptation of filter technics in commercial TV receiver filter for use with 300 ohm line by Eldico

is maintained between the axes of the coils (which are parallel) and an imaginary line connecting their centers. (The exact angle is one having a tangent equal to $\sqrt{2}$.)

In mounting, such a filter is connected in the antenna lead as close as possible to the TV set input jacks. The case (shield) is usually grounded to chassis, although with some receivers it may well be left floating. The filter causes little insertion loss in the TV bands and in some cases is installed as a general principle on the chassis by the service man before delivery to a customer. Table 1 gives the equations by which the filter arrangements shown can be computed. Here R equals the line impedance, each way, and F is the cut off frequency in megacycles. The values derived are in microhenries and microfarads. In practice capacitors having ±10% of these values and coils based on either Q-meter or inductance formula values will operate satisfactorily.

Other designs can be made up for the filtering interfences from TV bands 7 to 13 should a separate dipole connection be available on the receiver. Here a cutoff of 167 MC can be assumed.

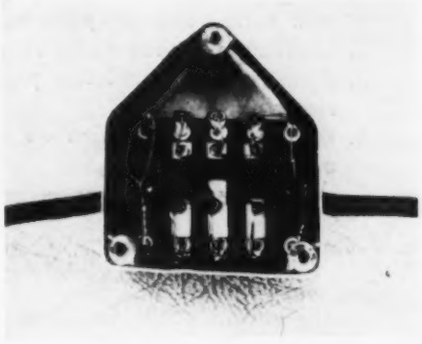


Fig. 5: High pass filter for 75 ohm coaxial cables, manufactured by Eldico

The second part of the job consists of a low-pass filter design suitable for use on amateur transmitters operating at 10 meters or higher, where antenna radiation at the fundamental and its harmonics are prone to cause TV interference. Installed between the set and the antenna, or the antenna tuning circuit, it effectively cuts off all radiation above 40 MC. This filter differs from the preceding designs in two ways: it uses a low-pass circuit conformation and it must have heavy enough components to handle the transmitted power. Several

(*Continued on page* 48)

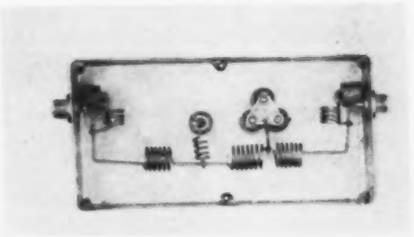


Fig. 6: Commercial heavy duty form of low pass filter illustrated in Fig. 3

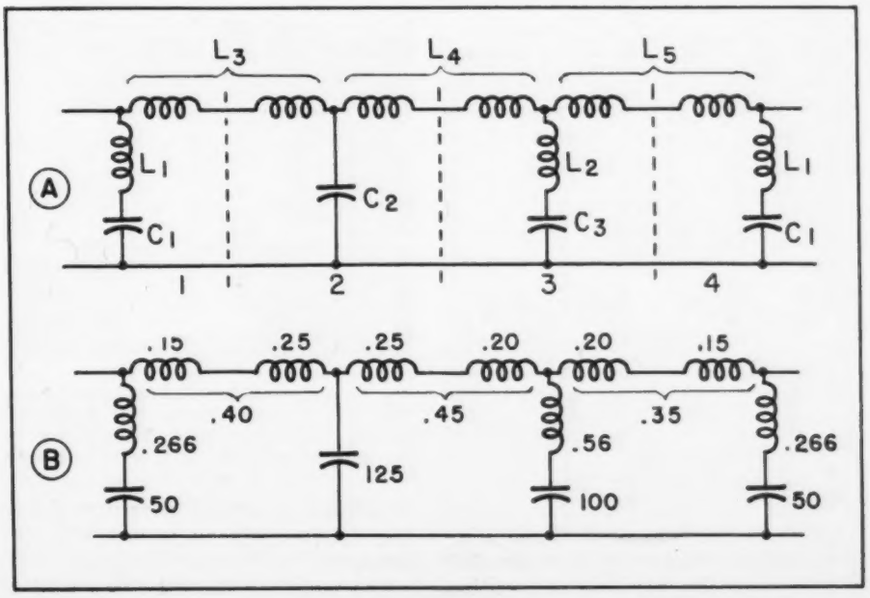


Fig. 3: Practical version of low pass filter suitable for use with transmitters operating at lower than television frequencies is shown in diagram above. Circuit constants depending upon line imedance and cut-off frequency (F) are given in the table below

	L_1	L_2	L_3	L_4	L_5	C_1	C_2	C_3
FIG 1A	0.26 R/F	0.08 R/F	—	—	—	0.15/RF	0.2/RF	—
FIG 1B	0.26 R/F	0.08 R/F	—	—	—	0.15/RF	0.1/RF	—
FIG 3A	0.17 R/F	0.036 R/F	0.255 R/F	0.286 R/F	0.298 R/F	0.095/RF	0.318/RF	0.255/RF

R = OHMS LINE IMPEDANCE F = FREQUENCY IN MEGACYCLES

Single Pulse Recording

Pulse-by-pulse photographing technics which reveal many

By LAWRENCE C. MANSUR,

Air Force Cambridge Research Laboratories, Cambridge 39, Mass.

ALTHOUGH the photographic technics described in this article were initiated for the purpose of investigating fluctuations of "fixed" targets and their effect on MTI operation, they are finding application to many other research problems. Single Pulse Photography promises to be of great assistance in:

1. **Design of Air-Traffic-Control Radars that use high scanning rates with narrow antenna patterns.**
2. **Location of desired Radar Signals in presence of noise.**
3. **Adjustment of oscillators providing high r-f power in the centimeter wave bands**
4. **Distortion determination on supersonic delay lines for MTI and computer use.**

DURING preliminary investigations at Cambridge Field Station of the limitations of Moving Target Indication, it became evident that a thorough study of the radar return from various fixed and moving targets was required.* Conventional "A" scope observation and photography was found to be inadequate for this purpose since the information is integrated on the eye or film and rapid changes are not recorded. The advantages of single pulse photography, where each video return is recorded, was apparent. Fortunately, commercially available equipment, with but minor modifications, proved suitable for photographing repetition rates as high as 4000 pps, and sweeps as fast as 5 microseconds. This technic has proved of great value in the study of fluctuations of radar echoes.

Separate photographs of successive video pulses have been made as early as 1942 by Lawson at Radiation Laboratory.[1] At that time propeller modulation was studied. Later work of Goldstein[2,3,4] and others increased greatly the knowledge of fluctuations of so called fixed targets. Improved technics, to study changes in the pulse shape as well as amplitude, has fostered new interest in pulse-to-pulse photography, particularly as applied to the analysis of the limitations of MTI equipment and tracking-while-scanning circuitry.

The radar used in these tests is a preproduction AN/CPS1 equipped with MTI, located at Bedford Airport, Mass. Its constants are (1) Beam width 1°, (2) Pulse repetition frequency, 300 pps, (3) Peak power, 800 kw, (4) Pulse width, 2 microseconds, (5) Noise figure, 12 db, and (6) r-f wave length, 10.7 cms.

The coherent MTI* utilizes a limiting receiver with balanced phase detector. The coherent oscillator operates at 30 MC. The local oscillator is stabilized by a high Q echo box. A mercury delay line operating with a 10 MC carrier frequency is incorporated in the cancellation circuits. Trigger stability is assured by using a second mercury delay line in the trigger generation circuits.

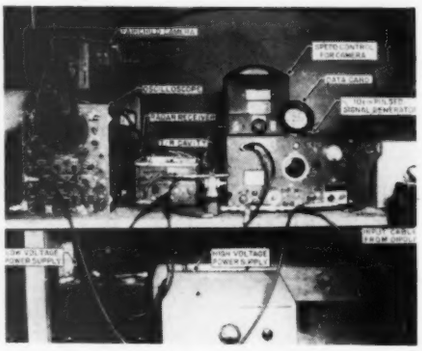


Fig. 1: Equipment installed at radar target, Oak Hill, Harvard, Mass. This equipment records photographically the stability of the incident radar signal after 14-mile jump

The target chosen for these studies (Oak Hill, Harvard, Mass., 14.2 miles away) presents an abrupt, heavily wooded face towards the radar. The slope is such that the range displacement of the upper 150 ft. is 3/10 mile (1.5 pulse widths). Several buildings of Harvard University, Department of Astronomy, are on the hill facing the radar. At the peak of the hill there is a 75 ft. steel fire-warden's tower. The average of the maximum amplitude of the signal is 58 db above minimum discernible.

Monitor Signal Photographed

To detect any receiver-indicator instability a monitor signal produced by a 10 cm pulsed signal generator is photographed simultaneously with the radar signal. This signal is fed into the wave guide ahead of the T/R tube. A series of still photographs is taken on the first few feet of film while the signal generator is attenuated by fixed steps. Thus a r-f power vs. deflection amplitude scale is obtained for each 100 ft. reel of film.

Preliminary photographs of successive pulses indicated large pulse-to-pulse fluctuations. To assure that these changes were inherent in the target and not produced in the radar, particular care was taken to stabilize the radar itself. By field-strength measurements at the target and the radar antenna was slowly turned and secured where the signal was a maximum.

Voltage-regulating transformers were connected to the receiver, the signal generator and the oscilloscopes. Batteries were used as a bias-gain-control source for the receiver and also to obtain reflector voltage for the klystron of the signal generator. Since a cancellation ratio of 30 db is obtainable in the MTI, it was assumed that the local oscillator, the coherent oscillator, and the trigger stability would not be limiting factors.

The DuMont 248A oscilloscope

*Coherent-phase moving target indication systems are used for the detection of moving targets which are surrounded by numbers of fixed objects, through the comparison of an echo pattern from a succession of pulses. In one form the echo pattern is delayed until another has arrived and the two are superimposed with correct phase so that the "fixed" parts are canceled. Valuable information is obtained by recording these echoes on film.

# of Radar Displays

propagation variations in moving target indicators

used is equipped with the 5RP11 cathode ray tube for photographic recording. However, in order to obtain well-exposed negatives with a 5 microsecond sweep, it was found necessary to modify the oscilloscope so that post-accelerating voltages up to 30 KV from a DuMont type 286A source could be applied. The three voltage divider resistors were replaced by 25 megohm 20 watt resistors enclosed in a drilled polystyrene block and mounted under

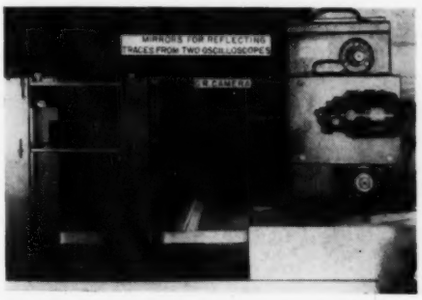


Fig. 2: Camera and mount for photographing three oscilloscopes simultaneously

the vertical amplifier control shaft. All high voltage leads were replaced with the RG84 cable from which the outer covering and shield had been removed. After the required connections had been made, five polystyrene plugs were cemented in place to seal the block, no plug being inserted at the ground terminal of the divider. The metal shaft on the Y amplifier switch was replaced by a lucite rod. Several coatings of Formvar enamel were applied to the cathode ray tube near the bond terminals and also to the Y positioning potentiometer. With these modifications no trouble from spark or corona discharge was experienced. By increasing the X axis 807 cathode resistor to 620 ohms 10W and the plate load resistors to 12K 25W, a maximum X deflection of 3½ in. was obtainable at 30 KV. No modification was made to the Y amplifier as a deflection of 1½ in. was sufficient.

A phantastron circuit was used to delay the sweep on the oscilloscopes so that only the range adjacent to the target was displayed. The signal generator was similarly delayed.

Two types of cameras were used The DuMont Type 314 with a maximum film speed of 5 ft/sec. permits suitable spacing between sweeps when the pulse repetition frequency is 300 pps or lower. This camera has provisions for making still photographs and therefore it is simple to photograph a data card and make a record of the signal generator calibration pulses.

For high repetition rates or for photographing more than one trace the General Radio type 651AE camera is required. Ample separation of sweeps occurring as rapidly as 2000 per second is possible with this camera using Eastman Kodak Linagraph Ortho film.

Since the target hill is located at the end of a 14 mile valley it was suggested that fluctuations observed in the radar echo might be due to variation in propagation and in particular by interference of multiple paths. In order to monitor the one way signal, photo recording equipment was installed at Oak Hill. A small parabola with dipole was mounted above the tree line on the steel fire warden's tower.

Five hundred feet of RG-17-U cable connected the dipole to a T/R cavity and hence to a receiver whose video output both triggered the oscilloscope sweep and, by means of a one microsecond delay incorporated in the 248A oscilloscope, was presented on the Y axis. A 10 cm pulsed signal generator was triggered at the same time and its output was inserted into the r-f cable ahead of the T/R cavity. The continuously-adjustable delay in the signal generator permitted placing the artificial signal adjacent to the radar signal. The calibration of deflection vs r-f power was done in the same manner as at the radar site.

A second dipole with reflector was mounted at the base of the tower below the tree line. The signal received by this dipole was fed into a second 10 cm receiver and then delayed by an additional four microseconds prior to presentation on the oscilloscope. So three signals are displayed: the received pulse from a free-space path, the received pulse after scattering by the foliage, and a signal-generator pulse. The

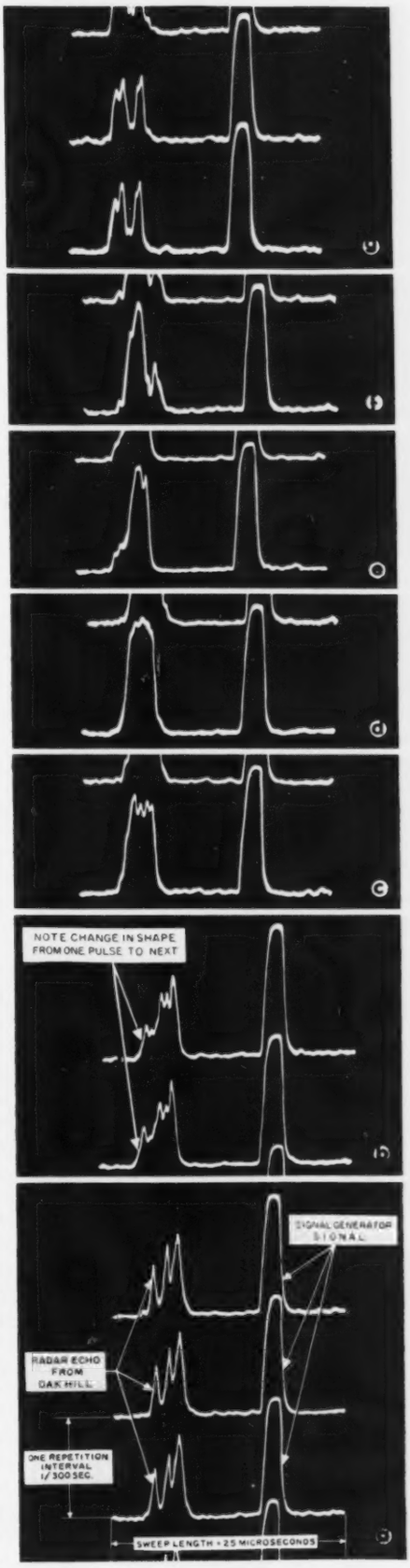

NOTE CHANGE IN SHAPE FROM ONE PULSE TO NEXT
SIGNAL GENERATOR SIGNAL
RADAR ECHO FROM OAK HILL
ONE REPETITION INTERVAL 1/300 SEC.
SWEEP LENGTH = 25 MICROSECONDS

Fig. 3: Sections from film containing 3600 shots, wooded hill and signed generator pulse. Parts a to g are at intervals of about one second apart. Continuous change in amplitude and shape of successive pulses are shown. At interval g the shape was returning to the approx. conditions of a

SINGLE PULSE RECORDING (Continued)

equipment used at Oak Hill is shown in Fig. 1.

To assure position identification between the individual pulses photographed at the two locations, a code was utilized. Approximate synchronization of the starting times for the two cameras was obtained by radio communication. In addition a motor driven rotary switch was inserted in series with the triggering circuit to deactivate the radar for one or two pulses at random intervals. Exact correspondence between the two films was easily obtained by observing the occurrence of the missing sweeps.

3 Oscilloscopes Photographed

For the analysis of MTI operation it is advantageous to have simultaneous photographs of normal video, coherent (phase sensitive) video, and MTI cancelled video. Although synchronization of three cameras is possible, it is inconvenient to compare three separate films. An optical system was devised whereby the General Radio camera photographed three oscilloscopes simultaneously. The oscilloscopes were mounted on a large table 90° apart and facing inward. The camera was placed at the fourth quadrant. Because the oscilloscopes were at slightly different levels, the three traces were at different heights. Two front surfaced mirrors each 6 x 1½ in. were placed to reflect to the axis of the camera the sweeps of the two adjacent oscilloscopes, while the third oscilloscope was photographed directly. The film speed of the GR camera is sufficient to give ample spacing between successive groups of three images. The location of the camera and mirror frame is shown in Fig. 2. A light tight hood is lowered over the equipment when photographs are being taken.

Normal Video Fluctuations

The oscillograms in Fig. 3 are sections from one roll of film, where the total exposure time was 12 seconds, which in turn means that 3600 pulses were photographed. In each case the start of the sweep was delayed to include the range adjacent to the target. The total fluctuation of the signal generator is under ±1 db indicating a good overall stability while the signal varies by 15 db.

Of particular interest in this film is the change in pulse shape and in pulse amplitude which occurs as a function of time. The total time elapsed is slightly over six seconds for the series reproduced here. During this interval the pulse changes from a positive slope to a maximum, to a negative slope, and to a two spiked minimum. A similar cycle of changes occurs again during the next six seconds of film exposure. At the time this film was exposed the deciduous trees were bare of foliage. A wind of 14 mph was blowing.

Fig. 4 shows the pulse arriving at the target while the corresponding radar echoes produced by these pulses is shown in Fig. 5. In Fig. 4 the initial deflection is produced by the elevated receiving dipole. All fluctuations in amplitude of this

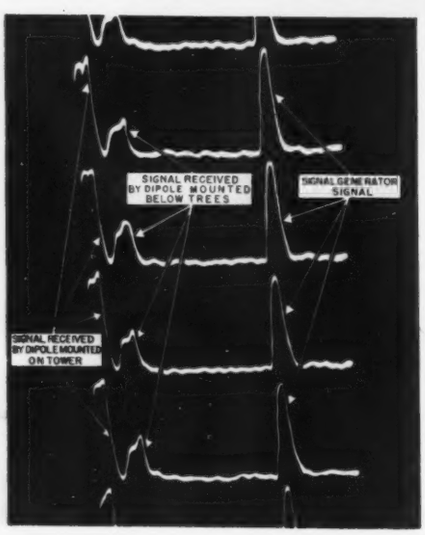


Fig. 4: Record of signal incident to radar target. Only minor changes are evident in free path signal (left), but that arriving below the tree line is fluctuating rapidly

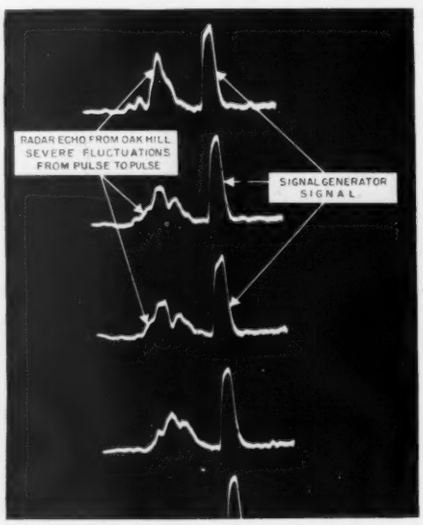
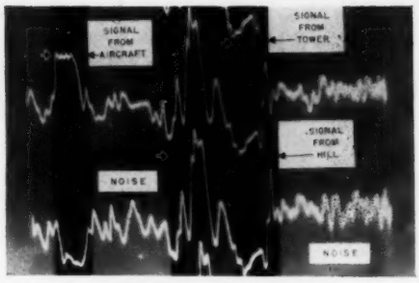
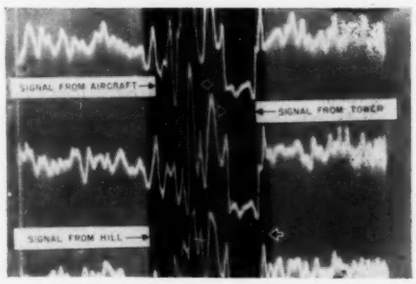
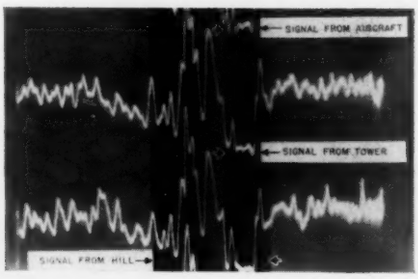


Fig. 5: Radar echoes produced by the pulses of Fig. 4. Amplitude changes between pulses exceed 7 db, while those received above tree line at the target remain constant







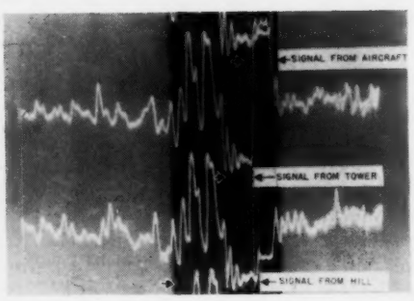


Fig. 6: Coherent (phase sensitive) video showing return from aircraft approaching wooded hill all from one 100' roll of film. Changes in amplitude and polarity of aircraft signal are produced by its motion. Signal from the hill shows no change between pulses. The far section of the signal from the hill is believed to be caused by the steel fire tower. Sweep length 25 micro seconds. Second group of pulses taken 6.0 seconds after top plate when aircraft was directly above the near portion of the hill. Third group shows pulses taken 2.3 seconds after last. The aircraft position now coincides with hill. Aircraft signal is almost completely masked by the hill top with its steel tower. Bottom group were found 1.2 seconds later. The aircraft emerging from the hill is easily located by the change in shape which occurs from pulse to pulse.

video are less than ±1 db. The adjacent pulse is the video from the dipole which is below the tree line. A careful study of the pulses shows slow changes in amplitude and shape. The remaining pulse is from the signal generator to monitor the receiver stability and to produce the deflection scale for the whole film.

Several sets of film have been exposed at Oak Hill and at Bedford simultaneously. No fluctuation of the received signal over a free path has been found to be more than ±1 db while the signals arriving below the tree line and the echo received at Bedford fluctuate by ±5 db and ±7 db respectively.

Fluctuations of MTI & Coherent Video

To further the study of fluctuations, pulse to pulse photographs are being made of the output of a limiting MTI receiver (coherent video) prior to the cancellation process. In this video, which is bipolar, any change in amplitude from pulse to pulse represents a change in r-f phase. Thus if photographs of coherent video are taken simultaneously with those of normal video, it is possible to determine if amplitude changes and phase changes occur at the same time. Data of this kind which should permit determining the velocity components of the moving vector produced by fluctuations, is being carried on.

The primary reasons for having MTI are twofold. First, MTI equipment should cancel all fixed targets and, secondly, it should enhance moving targets which are in the area of strong fixed targets. The second criterion has been termed sub-clutter visibility. The ability of MTI to discriminate between a fixed and moving target may be evaluated using pulse-to-pulse photography.

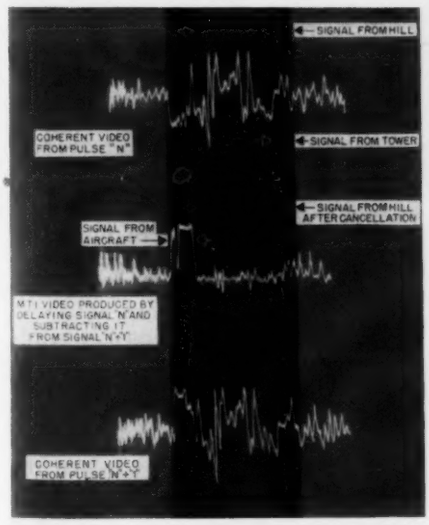

SIGNAL FROM HILL
COHERENT VIDEO FROM PULSE "N"
SIGNAL FROM TOWER
SIGNAL FROM HILL AFTER CANCELLATION
SIGNAL FROM AIRCRAFT
MTI VIDEO PRODUCED BY DELAYING SIGNAL 'N' AND SUBTRACTING IT FROM SIGNAL 'N+1'
COHERENT VIDEO FROM PULSE 'N+1'

Fig. 7: Aircraft approaching hill, coherent and MTI-video. The upper and lower trace are coherent video. The upper is delayed one pulse repetition interval then subtracted from the lower video. The result of the subtraction is the MTI video (center). This plate and the following one Fig. 8 were made with the one camera and two scope setup

Photographs were taken of successive pulses of coherent video reflected from an airplane (F4U4) flying a radial course over Oak Hill. Sections of this film are shown in Figs. 6 to 18. In the top section the plane's echo is evident at the left hand side of the sweep. Since its course was radial at an optimum speed the phase change from one pulse to the next is large. The return from the hill is not varying rapidly in phase since wind velocity was low at the time (4 mph) and flutter due to motion of foliage was negligible. The signal from the hill is of interest. The near section of this return (left) shows a complicated phase pattern produced by the undulations in the terrain. The far

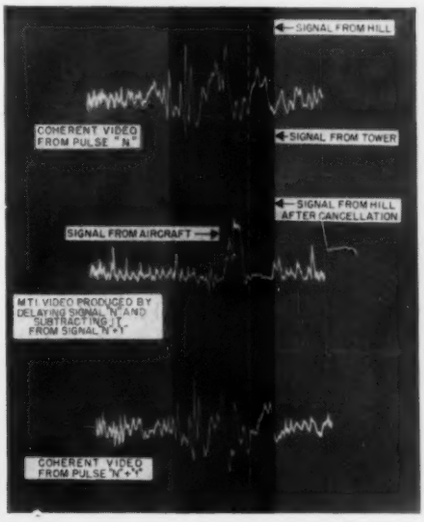

SIGNAL FROM HILL
COHERENT VIDEO FROM PULSE "N"
SIGNAL FROM TOWER
SIGNAL FROM HILL AFTER CANCELLATION
SIGNAL FROM AIRCRAFT
MTI VIDEO PRODUCED BY DELAYING SIGNAL 'N' AND SUBTRACTING IT FROM SIGNAL 'N+1'
COHERENT VIDEO FROM PULSE 'N+1'

Fig. 8: Same as Fig. 7 but aircraft is now directly over hill. Coherent and MTI video photographed simultaneously

element of the signal has a definite single phase. It seems reasonable to assume that the right hand segment represents the fixed vector produced by the top of the hill which is bare and particularly by the steel 75′ tower at the peak. It should be pointed out that the coherent video signal from the hill is similar in all photograph records made to date.

In the next section down 6.0 seconds later, the signal from the aircraft is in the near portion of the

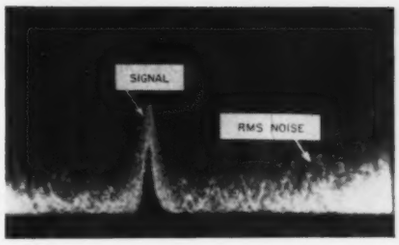


Fig. 9: Conventional photograph of signal and noise. Signal/noise ratio = 2. Exposure time 1/5 second pulse repetition rate 300 pps, sweep length interval was 25 μ-sec.

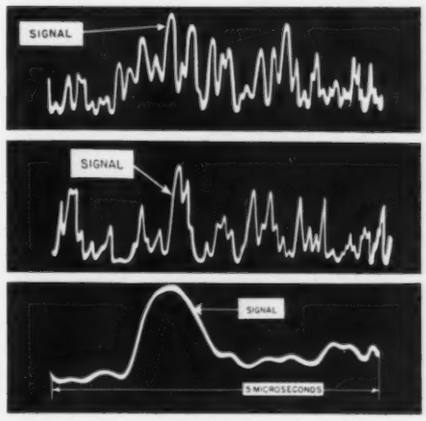


Fig. 10: Photographs of successive sweeps of signal and noise. All conditions identical with those in Fig. 9. In the upper photo the signal is not readily discernable due to large amplitude noise plates. Bottom photo represents expanded sweep (5 micro secs.)

hill and a change in the shape of the return is evident from one pulse to another. Next (2.3 seconds later) the aircraft now above the peak of the hill, produces change in shape of the pulse from one image to the next since the ratio of the signal of the peak of the hill with the steel tower to the signal of the aircraft is greater than the MTI enhancement. Finally, 1.2 seconds later, the plane is clear of the hill (bottom section).

The technic of photographing three videos with one camera was not developed to the stage of complete reliability when the tests were made with the F4U4 aircraft. However, simultaneous photographs of coherent and MTI video were made. In Fig. 7. Here the plane is approaching the hill but is in the clear. The phase change in coherent video from the upper pulse to the lower, at the left of center, is evident. The cancellation circuit subtracts the lower pulse from the upper (which is delayed one pulse repetition time). The output after subtraction is shown in the middle, MTI video.

Fig. 8 was taken when the position of the aircraft coincided with

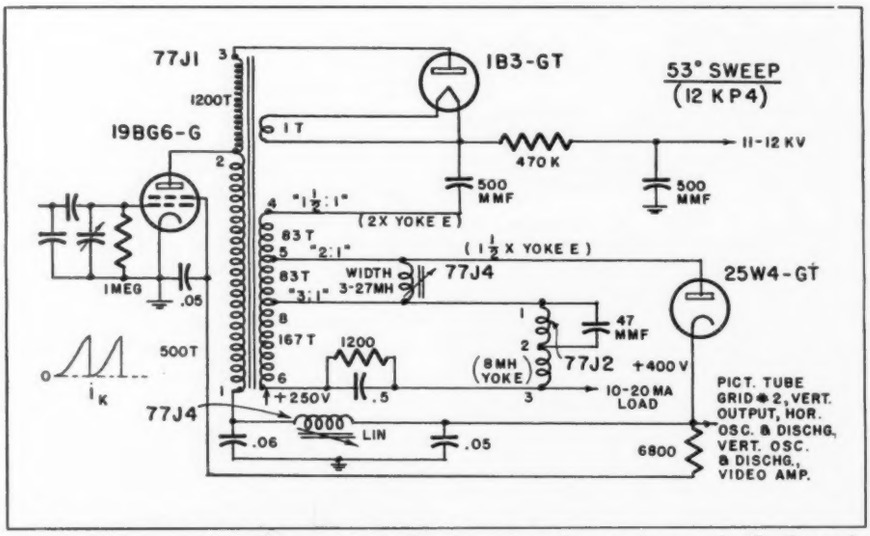
(*Continued on page* 54)

A Universal Ceramic Iron Core Sweep Transformer

Newly designed units may be employed for all magnetically deflected picture tubes ranging from 8 to 19 in. in size and operate at increased efficiency

By C. E. TORSCH, Cathode Ray Sweep Systems Engineering, Receiver Division, General Electric Co., Syracuse, N. Y.

PART TWO OF TWO PARTS



12KP4 type circuit with 12 kv sweep from 250-v B supply voltage and power feedback supplying sweep oscillator, driver screen and plate voltage boost as well as vertical sweep output stage voltage supply boost. A single 1B3-GT HV rectifier tube is employed.

THE most controversial factor in the application of sweep output transformers appears to have been the mode of driver tube anode circuit operation. Many sweep systems have been put in commercial operation without even an approximate definition of the level of plate dissipation within the driver tube. No simple or direct method of determining this dissipation level has appeared to date.

Two possible methods suggested themselves during application tests of the new transformer and are offered as sufficiently accurate, erring slightly on the pessimistic side of true values, for complete design checking.

Average plate dissipation in any tube is obtained by computing the product of the average plate current, as read on a moving coil meter (well bypassed for AC) and the average voltage effective from plate to cathode within the tube. The latter factor has been troublesome in the case of beam power tubes, particularly in the sweep application, where measurements are upset by the presence of high amplitude switching transients in every cycle of the plate voltage wave tending to obscure the fundamental data sought.

Substitution Method

The more easily described method of determining effective plate-to-cathode potential for dissipation determination is more accurate but more awkward to perform. In general, an artificial set of dc operating conditions is established on the basis of equivalent average current division between tube elements at a reference level of total and component tube currents, at a known interelectrode potential drop for all but one conducting path.

An accurate set of sweep circuit operating data should be taken, including:

(a) The grid #2 (screen) voltage to cathode as read on a high sensitivity, well bypassed moving coil meter.
(b) Grid #2 current
(c) Plate current from supply, as distinguished from total cathode current
(d) R.M.S. heater voltage at tube socket.

The specific output tube has in the above points supplied enough evidence to complete this stage of the test, and may then be removed from the sweep circuit and set up on separate d.c. supply voltages for grid, screen and plate, at the same time r.m.s. heater power input, if more convenient for the remaining step.

With heater and screen potentials set to duplicate the dynamic setup readings, adjust both the control *grid bias* and plate-to-cathode *supply voltage simultaneously* to produce the original *plate current* at settings which also reproduce the original *screen current*. No load or grid impedances need be inserted during this substitution test. The control grid bias value is not significant, but the plate-to-cathode voltage obtained is equivalent for dissipation calculations to the dynamic effective level.

Clipped-Rectification Method

A more detailed set of operating data taken from actual sweep circuit operation can be used for determining a slightly more pessimistic value of plate dissipation without resort to auxiliary setups. Reflection on the fact that the high positive plate swing of the driver tube is properly accompanied by plate current cutoff and hence results in no dissipation leads to the following propositions: clipping such a peak to the original supply voltage level permits integration of the remaining area to determine an equivalent plate-cathode voltage. Integration including the positive plate pulse would be in error by giving an averaged value of plate

voltage equal to the supply voltage, which is not reasonable in view of the cutoff condition existing during retrace.

Clipping of the plate voltage wave and integration of the remainder is most easily determined on the secondary side of the output transformer, where the biased damper tube is performing both functions in actual performance. Transposition of the derived data from secondary to primary is then straightforward.

To simplify the discussion it will be assumed that the yoke winding is isolated by a dc blocking capacitor, hence will not modify supply current flow. Any additional loads on the "boosted" voltage provided by the damper output are assumed to be connected directly to the damper cathode, rather than the primary end of the usual linearity control reactor. A plate to cathode drop characteristic of the damper tube type may be obtained from the manufacturer's tube handbook to simplify one of the steps to be taken.

Additional Operating Data

Additional operating data required other than plate current level are:

(a) Damper output (cathode) current
(b) Damper tube plate cathode average drop at the average current in (a)
(c) Output transformer primary winding dc resistance
(d) Winding dc resistance of portion of secondary feeding damper plate above dc supply tap
(e) Linearity control reactor dc winding resistance
(f) Integrated value of voltage from damper cathode to driver cathode, read on a high sensitivity moving coil meter (which may be bypassed for 15.75 KC ripple and provided with a series isolating resistor, small in value in proportion to meter multiplier)
(g) Supply voltage dc to secondary winding above driver cathode.

Steps to be Taken

The following steps should then be taken:

1—Compute the voltage drop in the damped secondary winding (d) for current (a).

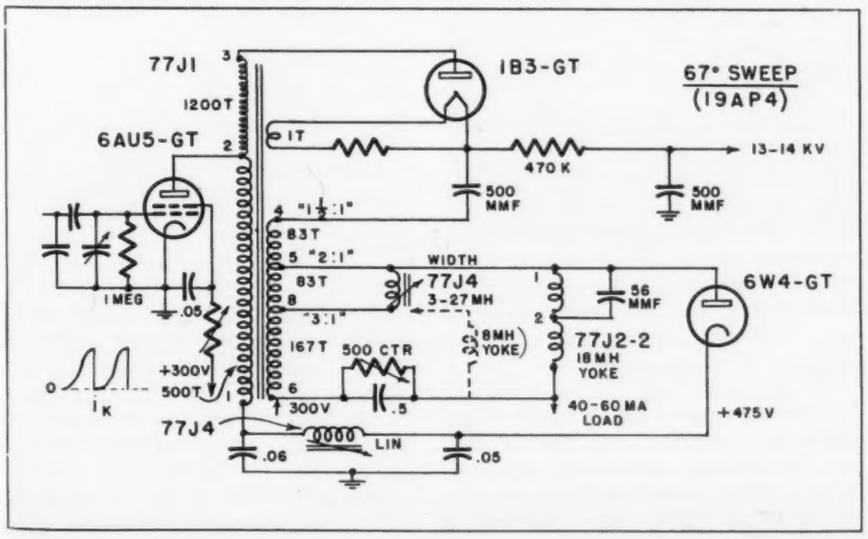
2—Compute the voltage drop in the primary winding (c) and linearity reactor (e) for driver tube average plate current.

3—Add (b) drop to (1) and to the difference between (f) and (g) voltages: this results in a value of total "clipped rectification" voltage developed within the secondary feeding the damper tube.

4—Multiply (3) by the turns ratio between the primary and damped section of the secondary: this results in a value of total "clipped rectification" voltage in the primary, neglecting leakage reactance losses between windings. Neglecting leakage produces a slightly pessimistic value for the final plate dissipation.

5. Deduct (4) and (2) from (f) to produce the required value of effective plate-cathode voltage for plate dissipation calculation.

19AP4 type circuit with 14 kv sweep from 300-v B supply and conventional damper and 6AU5-GT driver tubes. Again in this circuit, a single 1B3-GT rectifier is employed.



It is to be noted that this value of driver plate voltage is considerably above the instantaneous maximum of voltage at the driver plate during its conductive cycle.

An example of the methods described follows for a 293 volt supply voltage, the new G.E. 77J1 transformer, a 6AU5-GT driver, 6W4-GT damper, deflecting a 19AP4, 67° cone picture tube at 13.5 kv; all tube maximum ratings are observed. The horizontal oscillator was connected to the boosted supply feeding the primary. The damper was connected to the "2:1" secondary tap.

METHOD A

(a) $e_{screen} = 158$
(b) $i_{screen} = 9.5$ ma
(c) $i_{plate} = 68$ ma
(d) $e_{htr.} = 6.3$ v.
W screen — 1.5 watts
(1) substituted plate voltage = 102 v.
Plate dissipation = .068 × 102 = 6.9 W

METHOD B

$i_{p\ driver} = 68$ ma
(a) $= i_{r\ damper} = 71.5$ ma
(b) $= e_{damper\ drop} = 8$ V (Tube data)
(c) $= r_{pri.\ of\ transformer} = 40.5$ ohms
(d) $= r_{sec.\ of\ transformer\ across\ damper} = 17$ ohms
(e) $= r_{linearity\ control} = 30$ ohms
(f) $= e_{boosted\ from\ damper\ cathode\ to\ driver\ cathode} = 465$ v.
(g) $= e_{supply\ from\ driver}$
(1) $e_{drop\ in\ secondary\ ir} = (d) \times (a) \times .0715 = 1.2$ v.
(2) $e_{drop\ in\ primary\ ir\ and\ linearity\ coil\ ir} = {}^{i}p \times (c) + (a) \times (e) = .068 \times 40.5 + .0715 \times 30 = 4.9$ v.
(3) $e_{secondary\ developed\ to\ damper\ level} = (b) + (1) + (f) - (g) = 8 + 1.2 + 465 - 293 = 181.2$ v.
(4) $e_{primary\ developed} = (3) \times 2 = 362.4$
(5) $e_{driver\ plate} = (f) - (4) - (2) = 465 - 362.4 - 4.9 = 97.7$ v.
Plate dissipation = .068 × 97.7 = 6.7 W

The discrepancy between these two examples may be said to represent error due to incomplete cutoff of the power tube plate current during the retrace interval or accumulated metering errors.

The substitution method may be applied to any tube application for sinusoidal or pulsed plate swing with the single restriction of limiting control grid swing in the dynamic tests to zero bias if the driving source is a low impedance generator.

Part of this paper was presented at the Fifth Annual National Conference in Chicago Sept. 26-28, 1949 and will appear in Volume V of the "Proceedings of the National Electronics Conference."

Interim Report on Color-TV Hearings

Comparative demonstrations of rival systems show that color TV still needs considerable development

By FRANKLIN LOOMIS

THE latest step in the FCC Color Hearing, after the completion of direct testimony, was a two-day comparative demonstration held Nov. 21 and 22 in Washington. The color systems of CBS and RCA were shown beside black-white pictures produced on DuMont equipment. The purpose was to allow the Commissioners to make a side-by-side comparison, under home conditions, of these systems. Color Television, Inc. of San Francisco, will not have their apparatus ready for demonstration until February.

Demonstration Conditions

At the Studio—NBC's Wardman Park Hotel studio of WNBW was opened to competitors and three cameras were set up (CBS, RCA and DuMont) to view each scene. RCA's color signals were transmitted on channel 4 from WNBW; CBS's signal was relayed to WOIC and radiated on channel 9; a relay link transmitted the signals from the DuMont camera to WTTG, operating on channel 5. The latter station also broadcast the sound accompanying the pictures. Duplicate prints of the same motion picture were used for the film portion of the test.

At the Receiving Location—On the roof of the government building in which the receivers were located were erected standard TV receiving antennas, connected to the respective receivers. The signals on all three channels were of good strength, well above the noise level. Receivers, three to a room, were placed in three medium-sized rooms into which about 45 persons, some seated, some standing, could be crowded. Competitive receivers were grouped according to screen-size as follows: Room 1, CBS picture magnified to appear as a 16″ picture; 10″ RCA direct view (dichroic mirror type); DuMont 15″ picture receiver. Room 2, RCA same as above; CBS 12″ receiver; DuMont 12½″ set. Room 3, CBS color converter attached to a 10″ standard black-white receiver; RCA standard black-white picture 12″ size used to show compatibility of RCA color system with present standard.

The Commissioners, and other observers, divided into groups and spent some time in each of the three rooms. Through the facilities of the Am. Tel. & Tel. Co. it was possible to switch either the CBS or RCA color signals through either the coaxial cable passing frequencies up to 2.8 MC, or through a radio relay passing 4.0 MC. The effect of using the latter was not noticeable on either system but the coaxial cable removed all the color from RCA's signal because it suppressed the 3.8 MC "commutator" sync signal. The only effect of the 2.8 MC cutoff on the CBS picture was a slight reduction in resolution.

Program Material—This was discussed in preliminary meetings of a committee composed of representatives of the principals in the hearing. The advice of the majority, however, was over-ruled by the representative of the FCC, who was chairman. The result was a long-drawn out program. Instead of being of a type that could be observed and accurately recorded by technical observers, it was made up of average broadcast subjects. From this, only subjective impressions, difficult to record and easily forgotten, resulted.

The following illustrates the subject-material presented: commercial objects such as canned goods, acts in a variety show, puppets, short play, film, slides, women's program. Each of the three companies engaged in these tests supplied portions of the material used.

Results of Demonstration

Monochrome vs. Color—The DuMont equipment produced unusually sharp, contrasty pictures which, in the case of the majority of subjects, gave the viewer as much, and often more, *information* than either of the color pictures. It appears in TV, as in the movies, that color is *not* needed as a steady diet for entertainment. However, scenes can be selected which are meaningless without color, for instance, a flower garden.

Contrast—Many scenes which have but little contrast in monochrome are clearly and beautifully reproduced in color. However, it does not follow that color makes up for loss of definition if the information which the TV picture is to convey is contained in the moderately fine detail of the original picture; nor that contrast due to colors in the picture makes up for lack of brightness of the reproduced image.

Definition—It is understood that the RCA equipment had refinements made at both the studio and receiving ends after the October demonstrations. Projected pictures were not shown at the comparative demonstration so registration problems were reduced. The definition had been increased so that 325 lines from the resolution chart could be read. This was about the same as that obtainable from the standard monochrome system.

The CBS resolution remained at 180-190 lines.

Color Fidelity—In comparison with that shown by RCA the color fidelity of the CBS system is rated "excellent". There is still something to be desired along this line, however, for the faces of the Negro choir shown on the CBS receiver appeared yellow.

In the case of RCA the color fidelity was very poor. A purplish tint covered the entire picture for long periods of time. There were no good reds, and browns were missing. The receiver operators constantly tried to adjust the colors but the trouble, which was never explained, went deeper than this. Pure whites, a difficult test, could not be obtained. Large background areas of one color were often contaminated. RCA said they needed several months to make desirable improvements, so probably we can hope for a better color fidelity in the second comparative demonstration now scheduled for Feb. 23-24.

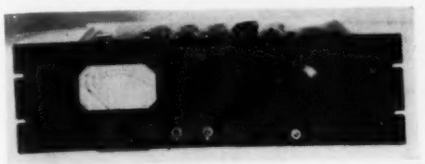
At the end of this two-day, side-by-side comparison it is believed that the television authorities present were unable to pick the system to be standardized. Instead, many expert observers said that both systems should be returned to the laboratory for more development work.

(*Continued on page* 50)

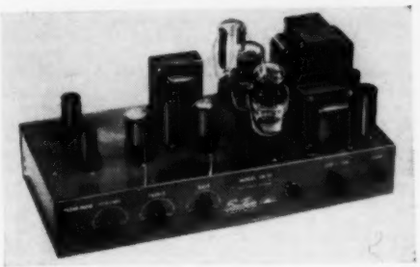
Sound & Recording Equipment

Volume Level Indicator

Type 820-A volume level indicator, designed for rack mounting, has a copper-oxide type indicating meter which possesses



nearly ideal characteristics for monitoring purposes. The adjustment is such that the pointer will indicate 99% normal deflection at zero vu in approximately 0.3 second. Overswing is not more than 1 to 1½%. Two meter controls are provided; one is a small decade with screw-driver adjustment for zero level setting of the meter pointer; the other a constant impedance "T" type network for extending the range of the instrument in steps of 2 db. Ranges of Daven indicators are: +4 to 42 vu and —20 to +20 as bridging instruments, and —6 to +16, —6 to +32 and —20 in the terminating types.—**Daven Co., 191 Central Ave., Newark 4, N. J.**



Amplifier Kit

An all-triode, high-fidelity amplifier kit (CR-10) based on a design recently published by Consumer's Research, Inc., Washington, N. J., is now being sold by the Sun Radio Co. It is a 10 watt, 7-tube unit and boasts flat frequency response (±1 db) from 20 to 15,000 cps. Distortion is reported as less than 2.5%, gain as 75 db on radio and 97 db on phono. Tubes used are: 1-6SC7, 2-6SN7, 1-6J5, 2-6B4G, and 1-5U4G rectifier. List, $42.50.—**Sun Radio & Electronics Co., Inc., 122-124 Duane St., New York 7, N. Y.**

Synchronous Tape Recorder

Reduced production costs of TV motion picture films are foreseen with the development and adoption of the "Pic-Sync" syn-

chronous magnetic tape recording and playback equipment. Time and labor costs are lowered by the speed-up of production that is accomplished with the instantaneous playback of sound tracks. Basic tape speed is 15-in./sec. with push button control to advance or retard the speed for "framing" sound and picture. When the push button is manually released the "Pic-Sync" control automatically takes hold and maintains synchronism between the sound-on-tape and pictures-on-film. No interwiring is required to synchronize the tape recorder with the TV or motion picture cameras or projectors. —**Fairchild Recording Equipment Corp., 154th St. & 7th Ave., Whitestone, N. Y.**

Magnetic Tape Recorder

A continuous-play magnetic tape recorder (810-DV), eliminating the usual continuous tape loop, has been developed which will re-

peat any message from 1 sec. to 1 hour in duration. Continuous repetition is achieved through double reversal of standard magnetic tape. Half the message is recorded on one sound track in forward tape travel, and the other half of the second sound track in reverse tape travel. Special solenoids are used which reverse the direction of tape travel in both directions virtually instantaneously (1/5 sec.). No adjustment is required on the recorder when a new message of different length is to be recorded and played back repetitiously. A small strip of pressure sensitive self-adhering metal foil is placed at each end of the length of tape required for the message which acts as the shorting arm of a switch, applying voltage to the reversing solenoids through sensitive relays.—**Amplifier Corporation of America, Twin-Trax Div., 398-26 Broadway, New York 13, New York**

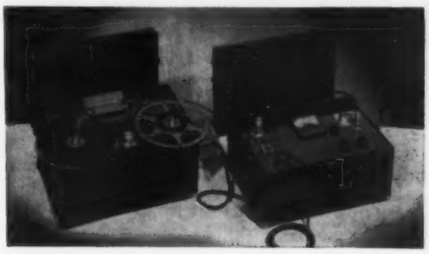
Speaker

Optical lens principles have been introduced into the manufacture of a new model loudspeaker (H-510) which employs a direct

radiator low end with a separate high frequency horn and compression driver for the high channel. Presence has been enhanced by attaining a wider angle polar pattern in the extreme high-frequency region where most simple and subdivided horns become undesirably directional. As in optics, the acoustic lens with its off-set circumferential slots and central opening, permits a controlled time delay by progressively increasing the acoustic ray path from the center to the edge of the lens. The result is a spherical wavefront maintained out to very high frequencies. This yields a polar pattern that is uniform over an unusually wide angle.—**Jensen Mfg. Co., 6601 South Laramie St., Chicago, Ill.**

Magnetic Tape Recorders

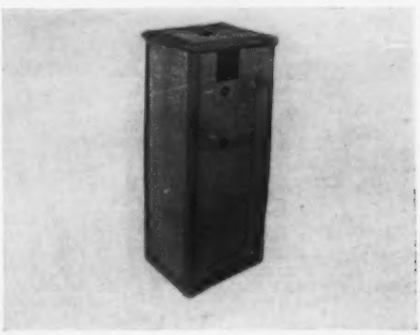
Two new professional models of Ekotape magnetic tape recorders have been designed to meet exacting audio standards. Both are



portable units. Model 105 consists of record and playback amplifiers in addition to the magnetic tape recorder mechanism, all mounted in a single unit. Model 107 (illustr.) is supplied in 2 sections; one contains the recording mechanism, the other contains the amplifier chassis. Both models are provided with single knob control for record, stop, listen and rewind. The synchronous 2-speed motor of model 107 moves the tape at a speed of 15 in./sec. for a full half hour program or a speed of 7½ in./sec. for an hour program.—**Webster Electric Co., Racine, Wisconsin.**

Stylus Shadowgraph

Because the Trac Shadowgraph was designed specifically for the viewing of a stylus point, it has been possible to dras-



tically cut the cost normally associated with optical comparators. This new unit is not an all-purpose laboratory instrument but it does provide a 500 times magnified view of the 2 cross sectional profiles of the stylus point, a perfect reproducing stylus curve as a comparison, a shaded screen for viewing, and a simple straight-forward focusing system which allows movement of the stylus in 3 planes. It is all-enclosed in a tough case of leather-finished, tempered masonite. The top of the case, surrounding the viewing screen, is at a convenient working height, 37 in. from the floor. List $93.75, FOB factory.—**Trac Tape Recording Apparatus Co., Box 221, Caldwell, N. J.**

Twin-Stylus Cartridge

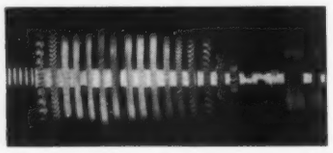
A new twin-stylus variable reluctance phonograph cartridge, the model RPX-050, is capable of playing conventional and micro-

groove records and is replaceable as a unit with sapphire tips having 1 and 3 mil tip radii. Stylus pressure with either stylus is 8 grams. The RPX-050, which is the same size as present models incorporating the replaceable stylus, features increased compliance and a very high signal-to-noise ratio. A smooth, wide-range frequency response curve is provided over the useful range of 40 cps to 10 KC.—**General Electric Co., Receiver Div., Syracuse, N. Y.**

New Parts & Components for

Test Record

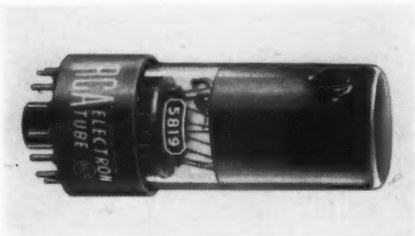
A new test record has been developed in which all the information needed by the engineer is annotated for cutting and repro-



duction. In cutting these records harmonic distortion has been kept to a minimum and extreme care throughout the processing cycle is maintained. The No. 2000S is a steady state frequency record, cut on 12-in vinylite, 78.26 RPM. It is recorded at constant velocity above 500 cps, constant amplitude below that point. The frequencies are from 50 cps to 10,000 cps below that point. Record No. 2001/2002S is a similar steady state recording for LP microgroove. One side of the record is recorded flat,—the other side with the NAB curve. List, $3.90 each.—**Clarkston Corp., 11927 West Pico Blvd., Los Angeles Calif.**

Multiplier Phototube

An outstanding feature of the 5819 phototube is its semi-transparent photocathode which has a diameter of 1½ in. and an area



of 1.8 sq. in. This relatively large cathode area permits very efficient collection of light from large-area light sources. The spectral sensitivity characteristic peaks at about 4800 angstroms and cuts off at approximately 3100 and 6500 angstroms. Utilizing 10 electrostatically focused dynode stages, the 5819 operated at 90 v. per stage is capable of multiplying treble currents produced at the cathode under weak illumination by an average value of 400,000 times.—**Radio Corporation of America, Tube Dept., Harrison, N. J.**

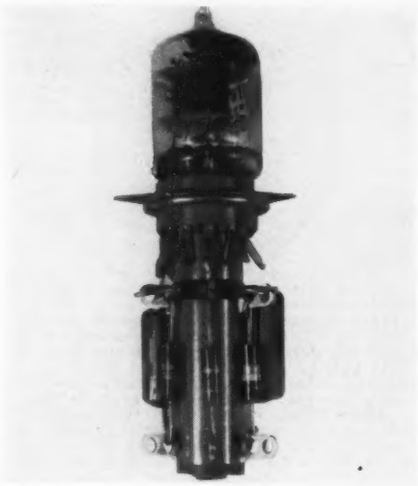
Console Tape Recorder

Tape economy and 66-min. recording time are combined with an audio response of 40 cps to 10 KC, ±2 db in the new Audiograph con-

sole tape recorder, operating at 7½ in./sec. A speed of 15 in./sec is available by instantaneous switchover, extending response to 15 KC and permitting split-word editing. Three plug-in chassis units contain recording, playback and power supplies for the electronic equipment. The recording amplifier accommodates input levels as low as —10 dbm, has plug-in tape equalizer for easy conversion to future tape developments. Tape transport mechanism handles 7400 ft. of tape on NAB standard hub, or RMA reels. Tape drive is by capstan and deformation-free retractable pinchwheel from a single hysteresis type dual-speed synchronous motor.—**Audiograph Co., 1422 El Camino Real, San Carlos, Calif.**

Socket-Turret

A new terminal structure has been developed on which circuit components associated with a vacuum tube may be neatly



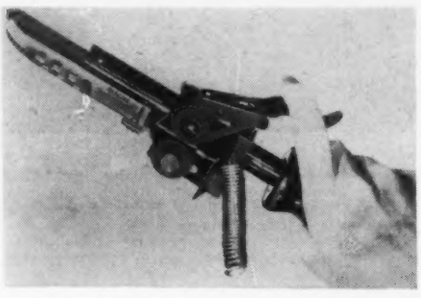
connected directly at the socket. Known as the "Vector Socket-Turret", it can be quickly installed with a minimum of connections. Stray capacitance is generally reduced since the number and length of circuit leads is minimized. These mountings are supplied in a variety of sizes and styles having octal, loctal, miniature or novel sockets of standard design.—**Vector Electronic Co., 1101 Riverside Drive, Los Angeles 31, Calif.**

Log Log Slide Rule

The new Pickett 800 Log Log all-metal slide rule simplifies the long-established, traditional Log Log scale arrangement through the use of a new double or "back-to-back" scale. The white or blank space saved by using the "back-to-back" scales not only makes it possible to include C scales on both sides of the rules but transforms the complex-looking maze of lines on the traditional Log Log arrangement into a simpler-looking and easy-to-use rule. A DI scale and a new, true ST scale are included. The permanently accurate, distortion-free magnesium alloy body weighs less than 4 oz. List, $14.—**Pickett & Eckel, Inc., 5 South Wabash Ave., Chicago, Ill.**

Soldering Iron Device

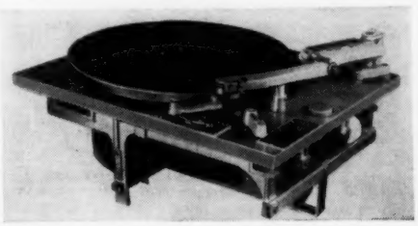
The Solder-Matic is a new, patented hand soldering device which automatically feeds solder to the tip of the iron. The feeding



attachment will fit any standard electric iron for 75 to 250 watts and can hold more than 6 ft. of solder from 1/16 to 3/16-in. diameter. Slight pressure on the trigger of the attachment brings the solder directly to the tip of the iron in the precise quantity necessary.—**Stern Corp., 436-A Fourth Ave., Pittsburgh, Pa.**

Professional Playback

"Floating Disc Drive," a system that has been installed in the new Proctor Soundex playback units, consists of a flexible alumi-



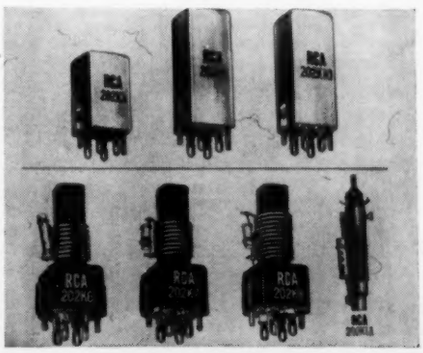
num drive disc, shock mounted at the center to the turntable shaft. The turntable shaft and drive disc are isolated from direct contact and the drive disc is held free by the shock mounting so that it is self-aligning with 2 drive rollers that it passes between. The position of these drive rollers along the radius of the drive disc control the speed setting which is continuously variable from 30 to 110 rpm. Transmission of rumble is prevented because the turntable is completely isolated from contact with drive rollers, and wow-free operation is facilitated because the drive disc is self-aligning and is not subject to inaccuracies of machining.—**Proctor Soundex Corp., 133 North Sixth Ave., Mount Vernon, N. Y.**

CR Tube

A multiple-intensifier-type CR tube (type 5XP—) featuring a highly sensitive vertical-deflection system has been developed in which potentials as low as 24 to 36 volts peak-to-peak are sufficient for 1 in. of vertical deflection on the screen. Even though the 5XP— may use high accelerating potentials, its deflection factor for plate-pair D_3—D_4 is one third of the deflection factor of similar tubes operating at low accelerating potentials. At overall accelerating potentials that may be as high as 25,500 volts, the light output of the 5XP— is sufficient for oscillographic applications that require the observation of high-speed single transients.—**Allen B. DuMont Laboratories, Inc., 1000 Main Ave., Clifton, N. J.**

Picture I-F Components

Designed for a sound I-F carrier of 21.25 MC and a picture I-F carrier of 25.75 MC, 7 new picture I-F components are available

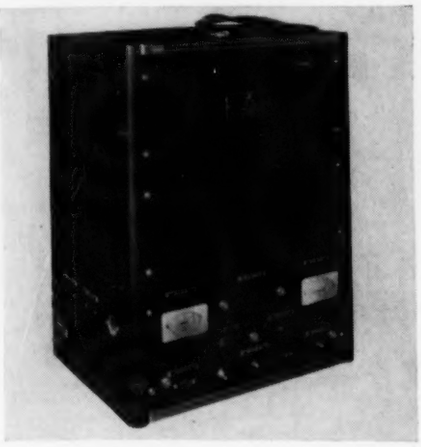


which give improved sensitivity, selectivity, and response. They are: converter transformer 202K5; 1st picture I-F transformer 202K6; 2nd picture I-F transformer 202K7; 3rd picture I-F transformer 202K8; 4th picture I-F transformer 202K9; 5th picture I-F transformer 202K10; and cathode circuit trap 202K11. When these components are utilized, the picture I-F system has more tuned circuits than any previous RCA picture I-F system. The use of link-coupled, double-tuned circuit between the converter plate and the grid of the first I-F tube increases the sensitivity of the system. This link-coupled, doubled-tuned input arrangement makes it practical to use a low-impedance line to couple the 1st picture I-F tube at some distance from the converter tube.—**Radio Corporation of America, Tube Dept., Harrison, N. J.**

Manufacturers & Laboratories

Power Supply

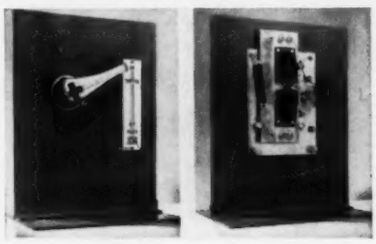
Model 224 power supply can provide voltages up to and slightly above 40 KV dc, with currents up to 200 μamps. Short circuit



current is about 3 ma and high voltage is provided by means of rectified 60-cycle voltage and a multiplier circuit. The use of 60 cycles guarantees long life and continuous reliability, and permits output control from 0 to maximum voltage.—**Beta Electric Corp., 1762 Third Ave., New York 29, N. Y.**

Handle Mechanism

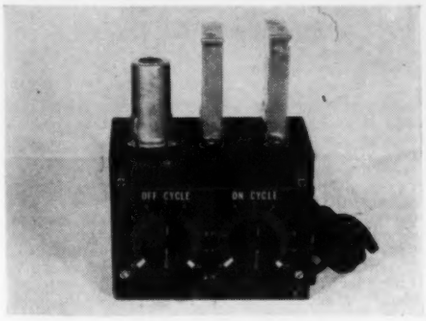
An improved handle mechanism for circuit breaker and control cabinets has been developed and is supplied with shims which



permit its use on covers up to ¼-in. thick. No critical adjustments, either horizontal or vertical, are required. Facilities for 3 locks are provided so that the mechanism can be locked in the "off" position. The cover cannot be opened when the cover is on the "on" position. An emergency opening arrangement, however, enables a qualified operator to enter the control box to make minor adjustments while the power is on, thus making it unnecessary to interrupt the cycling operation.—**Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa.**

Interval Timer

The "Cyclo-Flex" is an electronic timer which may be operated either single interval with manual initiation, or as a repeat cycle



timer with 2 adjustable intervals which occur successively without any internal operation. Each interval is accompanied by relay contact closure and is obtained by the charging of a resistance-capacitance network. Conversion from single interval to repeat cycle operation requires no change in wiring or additional equipment. Provision is made for the connecton of a foot switch or other manually-operated contactor.—**G. C. Wilson Co., 2 North Passaic Ave., Chatham, N. J.**

Pickup Arm & Cartridge

A curved, drawn steel arm (JL-10) and a new cartridge, developed especially for the arm characterize a new phonograph

pickup for 78 rpm record reproduction. Output is approximately 4.0 v., and needle pressure is 1½ oz. Complete specifications and prices are available from the manufacturer. —**Astatic Corp., Conneaut, Ohio.**

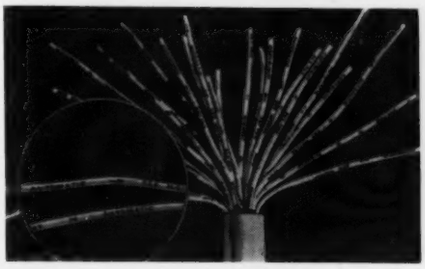
Voltage Regulator

A group of AC line voltage regulators and DC supplies that will work from 15 v. AC, 400 cycle line voltage have been designed

for use in aircraft, emphasis being placed on compactness and light weight. In general the specifications are: input voltage range, 95-215 v. AC, 400 to 800 cps; output voltage, adjustable between 100 and 120 v. AC; regulation accuracy, 0.5%; power factor range, down to 0.7 P. F. All units are fosterite treated for moisture and humidity protection. —**Sorenson & Co., Inc., 375 Fairfield Ave., Stamford, Conn.**

Numeral-Coded Wire

A coded wire for electric controls has been developed, using numbers instead of colors to increase the ease and accuracy of in-



stallations and maintenance. The manufacturer claims that the numerals do not wash nor wear off, nor become discolored with age. Known as Magic Wire, each strand has its code number imprinted in bright red on every inch of the yellow insulation. With terminals numbered to correspond with the numerals on the wire, it is claimed that installation costs can be reduced by as much as 50%. Magic Wire is available in No. 16 solid wire with plastic insulation. Other sizes and types and any specified brands of wire are available on request.—**Midwest Automatic Control Co., 510 Third St., Des Moines 9, Iowa.**

Double Diode-Triodes

Seven miniature double diode-triode radio tubes have been developed which provide improved rectifications of weak signals and

better minimum volume control operation. The new group includes types 6BT6 and 12BT6 with operating voltages indentical to older types 6AT6 and 12AT6; types 6BK6 and 12BK6 replace types 6AV6 and 12AV6; types 6BU6 and 12BU6 replace types 6BF6 and 12BF6. A new miniature, type 26BK6, has no complementary type but operates at the same voltages as others in the group with the exception of its 26.5 v., 70 ma meater.—**Sylvania Electric Products, Inc., 500 Fifth Ave., New York 18, N. Y.**

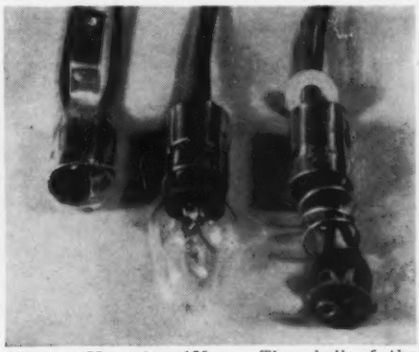
Oscillograph Tube

Designed for photographic recording of electrical phenomena, the new 3-in., oscillograph tube (3KP11) has sufficiently short per-

sistence for moving-film recording without blurring except when the film moves at high speed. The blue radiation of the fluorescent is highly actinic. This tube is also quite satisfactory for visual observation of phenomena because it utilizes an improved phosphor having unusually high brightness for a blue screen. Interchangeable with, and like the 3KP1 except for its screen characteristics, the 3KP11 has electrostatic focus, electrostatic deflection, high deflection sensitivity, and a "zero current for 1st anode" gun. This electron gun has a grid No. 2 operating at anode-No. 2 potential so that the beam current and grid-No. 1 cutoff voltage are not affected by focusing adjustment. The spot can be sharply focused on the screen, both at the center and at the edges.—**Radio Corporation of America, RCA Victor Div., Harrison, N. J.**

Indicator Light Socket

A newly-designed 110 v. indicator light socket has been designed which carries Underwriters' Laboratories approval for opera-

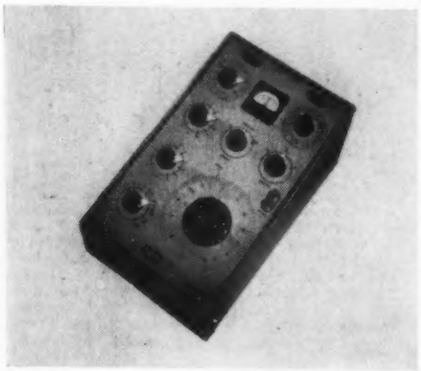


tion at 75 watts, 125 v. The shell of the socket is punched out automatically in a progressive die thus permitting low unit cost and absolute maintenance of dimensions. A simple spring and 2 washers are also used on the assembly and finally the leads with washer and contacts are attached. Every strand of the wire is brought into contact with the bulb and gives a file-like cutting action of wire to bulb base, with secure contact, free of noises due to motion or solder corrosion.—**Alden Products Co., 117 North Main St., Brockton 64, Mass.**

New Lab & Test Equipment

Impedance Bridge Kit

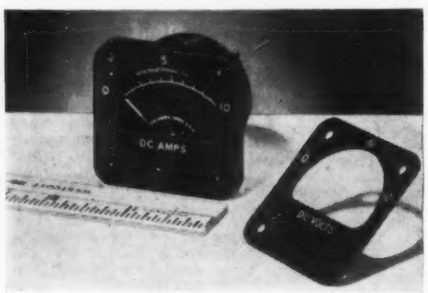
A new Heathkit impedance bridge kit has been designed with General Radio main calibrated control and 1000-cycle hummer.



Mallory ceramic switches with 60° indexing, 200 μamp. zero-center galvanometer and 0.5% ceramic non-inductive decade resistors are a few of the parts included. Inductance from 10 μh to 100 h., and capacitance from 0.00001 μf. to 1000 μf. can be measured. Resistance range is from 0.01 ohm to 10 megohms. Dissipation factor is from 0.001 to 1. —**Heath Co., Benton Harbor, Mich.**

Panel Meter

A single 1½-in. diameter panel meter with interchangeable face plates can be used on several ranges, merely by adding external



accessories and adding face plates. The dc self-contained instrument has a range from 50 to 500 μamps, from 1 to 500 milliamps, and from 1 to 15 amps. External shunts with leads are said to permit higher ranges. As an ac meter of the rectifier type, the range is 1 to 500 v. ac. External resistors can be added to provide higher ranges. Accuracy is claimed to be ±2% of full scale for dc operation; ±5% when used as an ac instrument. —**International Instruments, Inc., 331 East St., New Haven 11, Conn.**

Phase Monitor

Model 109 high precision phase monitor, designed for measuring phase relations at radio frequencies, has an absolute accuracy

of ±1° and resolution and repeatability of ±0.1° increments. Operator error is eliminated since readings do not depend upon the skill of the operator in making preliminary adjustments. The instrument continuously and automatically indicates phase difference and requires no manipulation on the part of the operator. Provision is also made to indicate antenna current in the various towers of a directional array.—**Clarke Instrument Corp., 910 King St., Silver Spring, Md.**

Voltohmeter

Model 103 voltohmeter has 5 db ranges from —4 to +64 db. in addition to 5 AC voltage ranges, 5 DC voltage ranges, 4 DC cur-

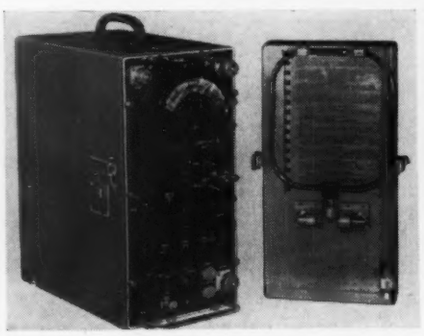
rent ranges and 3 AC current ranges. There are also 2 resistance ranges: 0-1,000 ohms and 0 to 1 megohm. The dial face is 4½-in. wide. List, $17.50.—**Electronic Measurements Corp., 423 Broom St., New York, N. Y.**

Power Oscillator

A new, exceptionally wide range power oscillator has been developed for measurement and testing procedures in the 300 to 2500 MC range. Known as the model 124A, the new unit consists of a grid separation coaxial oscillator employing a 2C38 disc seal triode, an audio oscillator and modulator section and a self-contained rectifier power supply. Cathode-grid and grid-plate lines are coupled to a single tuning control with provision for individual adjustment of the grid-cathode line, if desired. Counter type indicators show the position of tuning elements. An output coupling control with counter indicator is also provided. Delivery will be made within 6 months on single orders.—**Airborne Instruments Laboratory, Inc., 160 Old Country Road, Mineola, N. Y.**

Field Intensity Meter

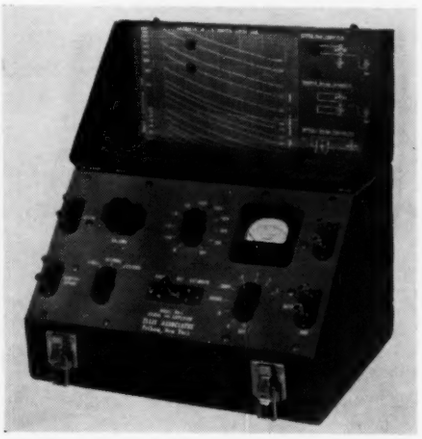
Field intensities of radio signals and r-f disturbances may be measured with a Stoddart NM-20A meter which operates from



self-contained dry batteries or external ac power unit. Either rod or a rotatable loop antenna may be used. Although the NM-20A is basically a field intensity meter and as such will check transmitters, antennas, and transmission lines, it also is particularly designed for the measurement of r-f energy other than sine wave, such as pulsed r-f and random noise interference.—**Stoddart Aircraft Radio Co., 6644 Santa Monica Blvd., Hollywood 38, Calif.**

Bridge and Amplifier

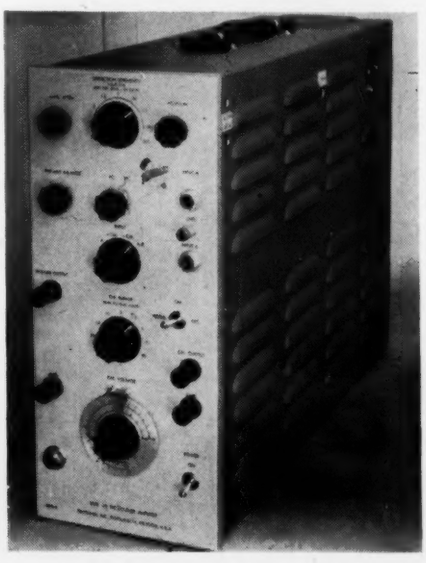
The BA-1 bridge and amplifier which has been designed for control of SR-4 gauges and similar instrumentation, is a complete pack-



age of bridge elements, signal chopper, calibration system, amplifier and power supply. Internal bridge elements handle either single gauge dynamic measurements or 2-gauge static and dynamic measurements. An entirely external bridge system which connects into amplifier input can also be used. The BA-1 will drive any standard oscilloscope and photographic records of transients, steady state and static signals of short duration can easily be made on a still camera. List, $350, F. O. B. Pelham.—**Ellis Associates, Box 77, Pelham 65, Mass.**

DC Coupled Amplifier

A bandwidth from dc to 1 MC can be provided by the 112 dc coupled amplifier when it is used at a maximum voltage gain of

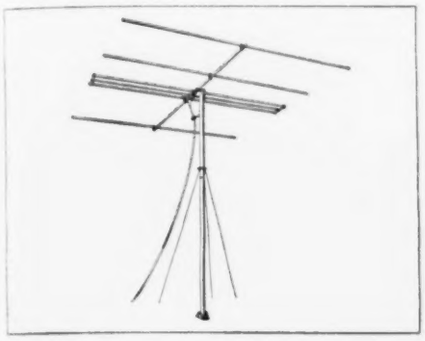


5000. For voltage gain requirements of 166 and less the bandwidth extends to 2 MC. An output of approximately 150 v. (peak-to-peak) is available to a high impedance load such as CRT deflection plates. Continuously variable control of gain, 15 to 5000, is accomplished by the combination of step and variable attenuator. This provides deflection sensitivities of 5 mv./cm to 50 v./cm when used with a cathode ray tube requiring 25 v./cm. The panel is appropriately marked. Amplifier is push-pull throughout with an input impedance of 1 megohm - 45 μμfd. each side to ground, or 10 megohms - 14 μμfd. each side to ground when using the probes which are supplied. Either single ended or differential input may be employed.—**Tektronix, Inc., 712 S. E. Hawthorne Blvd., Portland 14, Oregon.**

TV & Communication Components

TV Antenna

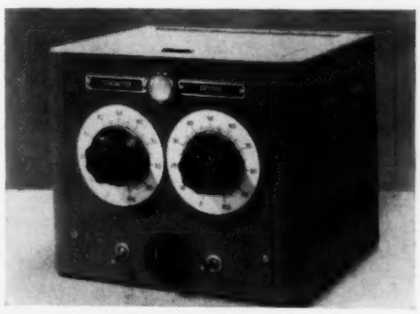
The use of a newly-developed double-folded dipole on the Yagi TV antenna gives an efficient impedance step-up so that the high



gain of a multi-element parasitic antenna may be utilized with direct feed to a 300 ohm line. Designed for extreme fringe area reception, this antenna is available for each of the 12 channels, though considerable gain may be expected on adjacent channels. The gain on the optimum channel is 10 db with a front-to-back ratio of 25 db.—**Trio Manufacturing Co., Griggsville, Ill.**

Transmitter Tuning Control

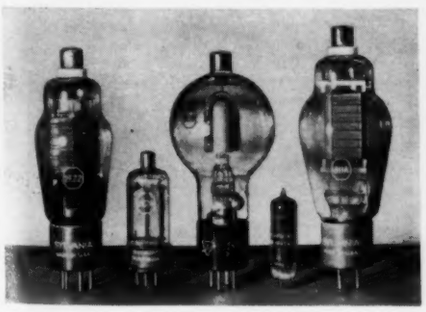
A novel control circuit which automatically resonates as many as 22 separate tuned circuits in sequence has been incorporated in



a new automatic transmitter tuning control, known as the 401-C. Low as well as high-power tuned circuits can be resonated in virtually any type of radio transmitting equipment. Compensation for variations in "Q" factor existing between various tank circuits is automatic.—**Electromatic Transmitter Co., 62 Basswood Ave., Providence 8, R. I.**

Transmitting Tubes

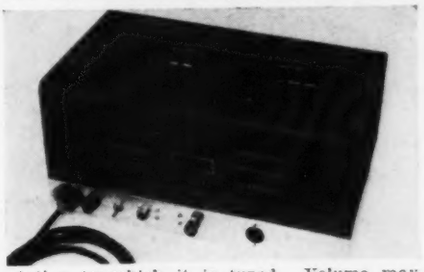
A vhf beam power amplifier, a pentode power amplifier oscillator, a miniature beam pentode, and 2 power triodes have been de-



veloped for transmitters with amateur, portable and mobile applications. Type 811A power triode (extreme right) is suitable as a class B a-f power amplifier and modulator; for plate-modulated r-f power amplification in class C telephony; as a self-rectifying amplifier; and as a class C amplifier. Type 808 power triode (center) is designed for use as an a-f power amplifier and modulator, class B; for plate-modulated r-f amplifier in class C telephony; and as an r-f power amplifier and oscillator in class C telegraphy. The vhf beam power amplifier, type 2E24 (second from left), has been developed for use as a plate-modulated r-f power amplifier in class C telephony and as an r-f amplifier and oscillator in class C telegraphy. Type 2E22 pentode power amplifier oscillator (extreme left) is suitable for class C r-f amplifier or oscillator service and as a suppressor-modulated class C amplifier. The miniature beam pentode, type 2E30 (second from right), may be used as a class A1, AB1 or AB2 a-f amplifier and modulator; r-f power amplifier and oscillator in Class C telegraphy; and as an r-f power amplifier in class C telephony.—**Sylvania Electric Products, Inc., Emporium, Pa.**

Storecaster Receiver

The entire operation of the S-17-A, FM receiver, (with the exception of being turned on and off) is controlled by the FM broadcast



station to which it is tuned. Volume may be raised when commercial announcements are made and lowered again when the musical program is resumed. The receiver responds to coded transmissions of pulses or tones which can silence the receiver or control volume. Unique features of the S-17-A are low r-f intermodulation characteristics, extreme stability, and high fidelity of I-F amplifier and audio section.—**Collins Audio Products Co., Inc., P. O. Box 368, Mountainside, N. J.**

Dark-Face TV Tubes

A "filterglass" face plate has been incorporated in two new 12-in. TV picture tubes which provide better contrast by reducing halation on the tube face and reducing reflections from surrounding areas. Designated as the 12KP4A (aluminized) and the 12LP4A (non-aluminized), the glass tubes have a face plate with a built-in filter. List prices in the East are: $47.10 for the 12KP4A and $44.40 for the 12LP4A—**General Electric Co., Syracuse, N. Y.**

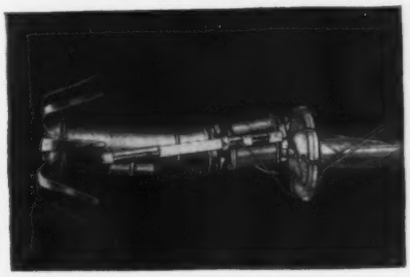
16mm Sound Camera

The "Cine-Voice" 16mm sound camera is driven by a constant-speed electric motor, allowing 2¾ minutes of continuous record-

ing. The complete system is reasonable ($695) and is ideal for short interviews and similar program applications in TV broadcasting. To record the actual sounds as they occur, along with the picture, it is only necessary to place the microphone out of camera ranze, adjust the amplifier and shoot. Camera weighs 12½ lbs.—**Berndt-Bach, Inc., 7379 Beverly Blvd., Los Angeles 36, Calif.**

Bent-Gun Ion Trap

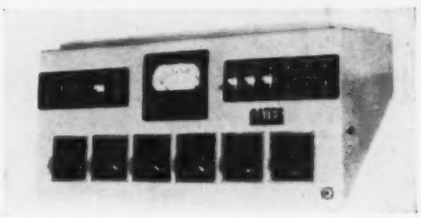
Better pictorial resolution as well as greater simplicity and economy, is claimed for the bent-gun trap featured by current DuMont



TV tubes in the 12½-, 15½-, 16-, and 19-in. sizes. In this design the electron and ion beam is aimed by bending the gun so that the ions will be trapped by the anode barrel structure, and the electron beam is then brought to the axis by the action of a single magnetic field. Two bending magnetic fields are required. The first magnet tends to make the beam travel away from the axis, while the second is needed to bring the beam back to travel along the tube axis.—**Allen B. DuMont Laboratories, Inc., Tube Div., 2 Main Ave., Passaic, N. J.**

Studio Console

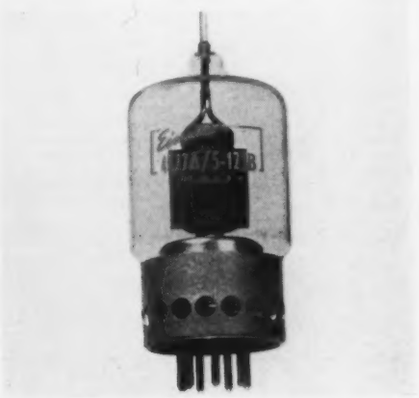
A medium-sized studio console (52-CS) that may be used for AM-FM or television in main or sub-studio service has a complete



self-contained speech input system with provisions for 4 microphones, 2 transcription turntables, network and remote lines. It is also provided with preamplifiers for microphones plus line and monitoring amplifier for the high level circuits.—**Gates Radio Co., Quincy, Ill.**

Pentode

Modifications introduced into type 4E27A/5-125B pentode contributes primarily to tube life, simplifies cooling, and increases the



maximum plate dissipation. Physical size and electrical characteristics make it directly interchangeable with type 4E27. Among design innovations on the new tube are features such as moulded-glass header, shell type base, low-loss leads, non-emitting grids and a Pyrovac plate. It is rated conservatively at 125 watts plate dissipation and is designed for vhf applications.—**Eitel-McCullough, Inc., 240 San Mateo Ave., San Bruno, Calif.**

New Parts for Design Engineers

Terminal Block

The need for wrapping wires around studs or applying terminals to wire ends is eliminated when the new solderless-type "Bepco"

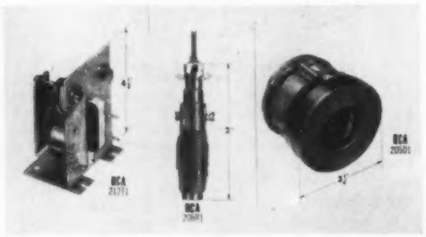
molded terminal blocks are used. These blocks are provided with compression type solderless units, each capable of receiving wires from No. 16 to 6 AWG. Wires are attached to block by tightening screws after insertion of stripped wires. Blocks are rated at 35 amps., 600 v. and are available in 4, 8 and 12 circuit sizes.—**Buchanan Electrical Products Corp., 1290 Central Ave., Hillside, N. J.**

Disc Ceramic Capacitors

Wafer-thin disc ceramic capacitors have been developed in ratings up to .01 or 2 x .004 μf, 500 volts DC working. Consisting of half-dime or dime-sized ceramic plates, these new components are of extremely high dielectric constant with silvered electrodes fired on both faces of the disc. Uni-directional leads are soldered to the silvering and the capacitors are coated with a tough, moisture-resistant insulating resin.—**Sprague Products Co., North Adams, Mass.**

Horizontal Deflection Components

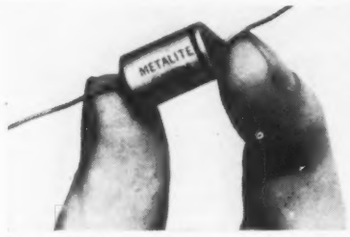
The 205D1 magnetic deflection yoke (right) is one of four new components designed for high-efficiency horizontal deflection systems.



It is intended for use with the 10BP4, 12LP4, and similar picture tubes having a deflection angle up to about 60° and operating at an anode potential up to 12 kv. The 217T1 horizontal-deflection-output and high-voltage transformer (left) has been developed for use with a single 6AU5-GT driver tube and two 1V2 rectifier tubes with a voltage-doubler arrangement to supply a dc output voltage up to 12 kv. The terminal board of the 217T1 contains 2 sockets for 1V2 rectifier tubes and provides mountings for 3 high-voltage capacitors. In addition, terminals are included for connections of width control 206R1 (center) and linearity control 207R1.—**Radio Corporation of America, Tube Dept., Harrison, N. J.**

Metallized Paper Capacitor

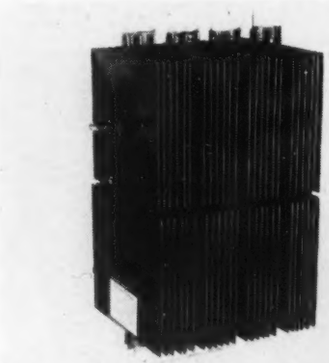
A new, improved midget self-healing metallized paper capacitor in both hermetically sealed and cardboard tubular designs has



been developed and are now available in voltage ratings up to 600 v. Known as "Metalite", these space-saving units are about one-third to one-fourth the size and weight of conventional capacitors now being manufactured.—**Astron Corp., 900 Passaic Ave., East Newark, N. J.**

Selenium Rectifier

Dual selenium rectifier elements measuring 7¼-in. x 12¾-in. have been developed for high current, intermittent duty, medium



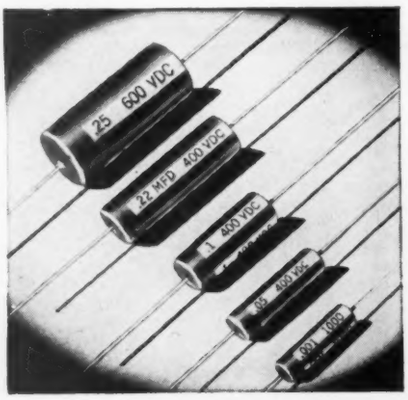
voltage (550 volts and below) applications. Each dual element consists of two 6¼ x 7¼ in. plates strapped in parallel and rated in a 3-phase bridge circuit at 34 amps., for continuous duty self-cooling; 85 amps. for continuous duty fan cooling; and 340 amps. for highly intermittent duty.—**International Rectifier Corp., 6809 South Victorie Ave., Los Angeles 43, Calif.**

Motor Controller

Fully magnetic in operation, a new manual motor controller and enclosed general purpose circuit breaker is available in single, 2- and 3-pole construction. The breaker is housed in NEMA type 1A dust-resisting steel enclosure. Features include a special type hinged cover which permits easy removal for wiring purposes, 8 conveniently located knockouts, and ample padlocking facilities. Maximum ratings are: 50 amps., 250 v. ac; 7.5 HP, 250 v., single phase 60 cps; 10 HP, 250 v., 3 phase, 60 cps; interrupting capacity of 5000 amps.—**Heinemann Electric Co., 99 Plum St., Trenton, N. J.**

Plastic Tubular Capacitor

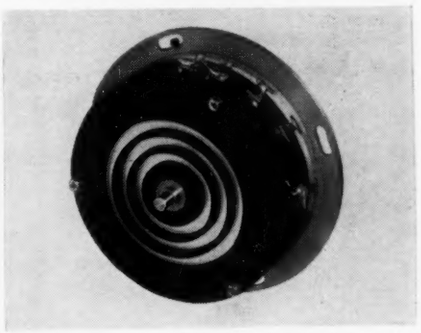
To all appearances the self-molded paper-tube plastic tubular capacitor (type 87) is the usual paper-tube tubular with sealed ends



and imbedded pigtail leads. But the type 87 has the same section, the same impregnant, and the same characteristics as the more-expensive Duranite capacitor except that it does not have a molded case. By eliminating the molded case (using the paper tube as a mold and case) marked economies have been effected. There is no liquid or liquefying impregnant to leak out, consequently the drip temperatures of the overall dip waxes will not be lowered. Operation of the type 87 at temperatures as high as 212° F. is possible. Also, its dielectric strength at the elevated temperatures is such that it can be operated at its rated voltage at 212° F. without danger.—**Aerovox Corp., New Bedford, Mass.**

Potentiometer

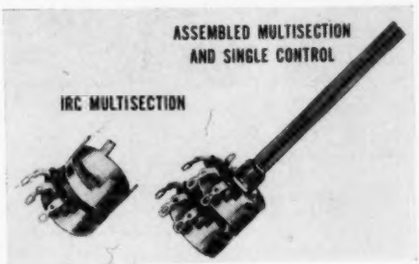
Model 748 differential computing potentiometer has been designed primarily for applications requiring the addition or subtraction



of 2 variables in a single unit, with 1 voltage source. It can replace 2 potentiometers when one is being used for compensation or correction purposes. Retaining the high inherent accuracy of a single potentiometer, this dual unit, through coin-silver precision slip rings in the cover plate, will produce a net voltage sum or difference when one variable rotates the shaft, while the other rotates the body of the potentiometer. Maximum overall resistance is (±10%) 150,000 ohms. Electrical angle of rotation is 354.5°, ±0.5°. Mechanical rotation is continuous and service life is over 1 million cycles.—**Fairchild Camera & Instrument Corp., 88-06 Van Wyck Blvd., Jamaica 1, N. Y.**

Ganged Potentiometers

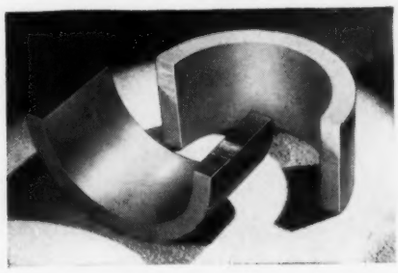
Complete control sections, designed for use with IRC's new miniature Q controls, can be added to types Q, PQ and RQ just as



switches are attached. Each "Multisection" adds 19/32-in. to the basic control, and with these units an endless variety of duals, triples, and even quadruples can be readily assembled without special tools. "Multisections" are supplied in 17 different resistance values, ranging from 1000 ohms to 10 megohms.—**International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.**

Deflection Yoke Shield

A new powdered-iron deflection yoke shield, in the shape of two half cylinders, saves tremendous time in the assembly operations on



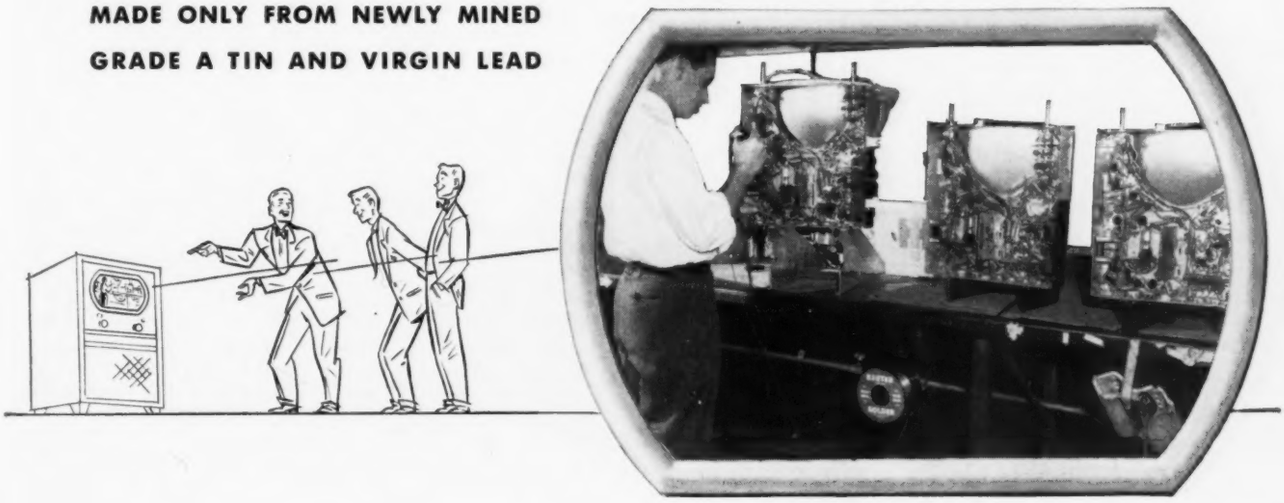
deflection yokes. In place of usual winding procedure with soft iron wire, the two cylinder halves are slipped into place around the electrical winding and held with a few wraps of tape. Cost of powdered-iron shields and soft-iron windings are approximately the same while electrical characteristics of the powdered iron are better than those of the iron wire.—**Henry L. Crowley Co., 1 Central Ave., West Orange, N. J.**

KESTER SOLDER

Build more quality into your TV sets with Kester "Resin-Five" Core Solder

TV—the nation's fastest growing business demands the nation's number 1 solder. Kester "Resin-Five" Core Solder, formulated especially for TV, will out perform any solder of the rosin-core type. It easily solders such metals as brass, zinc, nickel-plate, copper, and ferrous alloys.

MADE ONLY FROM NEWLY MINED GRADE A TIN AND VIRGIN LEAD



"Resin-Five" flux is more active and stable than any other rosin-type flux. Yet it is absolutely non-corrosive and non-conductive.

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WASHINGTON
News Letter

Latest Radio and Communications News Developments Summarized by Tele-Tech's Washington Bureau

PUBLIC TESTS OF COLOR-TV—The FCC having ordered the devisers of color TV systems to have receivers under public tests during December, January and February, some reports of video viewers should be ready before the color-TV hearings wind up. It was significant for radio engineers that field tests and experimentation in color video are to be both in the present black-and-white VHF band and the UHF 470-890 MC band. Color TV comparative tests resume Feb. 23-25 with the CTI (Color Television Inc.) showing, and further demonstrations of CBS and RCA systems. The further direct testimony and cross-examination phases of the FCC hearings resumes in mid-February and every indication is that the allocation-freeze proceedings will not be able to be started until April.

AM LICENSES IN DEMAND—That sound broadcasting still has its place in the sun is evidenced realistically by the continued flow of construction-permit applications into the FCC for new AM broadcasting stations. FM broadcasting, however, has shown a definite down-trend.

New FM applications have almost dried up completely so only 48 applications were pending in early December and a large number of approved construction permits for FM stations have even been cancelled.

MONUMENTAL PIECE OF WORK—Engineers are calling attention to fine achievement of the FCC in its allocations of frequency space for the several score of mobile safety and special radio services with their nearly 70,000 licensed stations. The allocations became effective Nov. 1 and in the months of November and December the new frequency assignments have been put into effect by the various land transportation, industrial, common carrier and safety licenses with hardly a creak and with no major hitches. The only complaints have been from a few minor special industrial radio services like store delivery vehicles etc. which in their operations did not qualify in the public interest.

$375 MILLION FOR MILITARY PROCUREMENT—For the remainder of the present government fiscal year which ends June 30, 1950, the three armed services have a total of around $375,000,000 for procurement of communications-electronics equipment and components which has been flowing out; appropriately at the Yuletide season, in contracts to the radio manufacturing companies. The Air Force has the largest fund—$163,000,000 of which some $45 million is to be expended for equipment for tactical electronic systems and $50 million is set aside for aids to navigation and UHF conversion of present facilities. The Signal Corps has the next largest amount for new procurement—$115,000,000, together with an added $15-20 million for procurement under the North Atlantic Pact military assistance program.

NAVY'S REMAINING APPROPRIATION—The Navy Department has available for the rest of this 1950 current fiscal year $68,472,000 for communications-radar-electronics equipment procurement. Of this the Bureau of Ships' Electronics Division has control of spending $52,532,000 for the equipment needs of the Fleet, the Navy shore facilities and the Marine Corps; and the Bureau of Aeronautics received an allocation of $15,940,000 for naval aviation. It will be recalled that, unlike previous years, Congress did not pass the appropriation bills for the government until the closing days of the session last fall and the fiscal year of 1950 had already been under way for over four months.

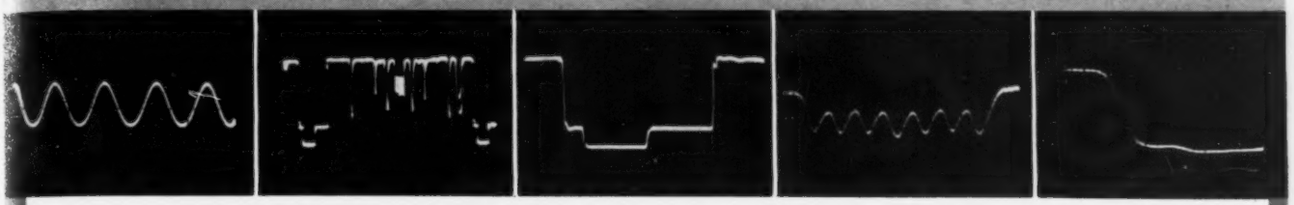
PROPAGATION, TROPOSPHERIC ETC. BEFORE FCC—The FCC's history-making television survey with its probing into the video medium of color, which has such a widespread popular appeal, shifts during this month (January) into a more basically important sphere—the consideration of the future Television Standards to fit both the present UHF and the upcoming UHF frequency bands. When the Commission reaches this phase of its proceedings, the general public interest and daily press coverage will diminish because the testimony will be on the highly technical subjects of propagation, tropospheric iinterference, polycasting, stratovision and the principles of allocation. For radio engineers this phase of the FCC proceedings will be of paramount significance and the Commission itself will find it of the greatest benefit in the plotting of television's course in the upper bands. Out of the technical evidence, the FCC will be able to evolve its all-important decision to lift **the "freeze" on television station** construction and location, a step which will speed the TV art tremendously.

MISCELLANY—Microwave systems now have come to forefront as the method proving most efficacious for many major mobile radio services, especially railroads, power utilities, and petroleum industry . . . FCC commissioner Sterling predicted recently that within three to five years 90 per cent of all taxicabs will be radio-equipped.

National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington Editor

THE T-V PICTURE-SIGNAL ANALYZED



Output of one of the marker oscillators used in setting sweep speeds to known values. This case represents 0.2 microsecond/inch.

1.2 lines of television signal. Horizontal synchronizing and blanking pulses at each end. Video modulation in center.

Fractional part of a line. Horizontal synchronizing and blanking are shown.

Fractional part of line near center of line. Video modulation produced by wedge, is shown.

Leading edge of horizontal synchronizing pulse.

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DU MONT Type 280-A *Cathode-ray* OSCILLOGRAPH

The Du Mont Type 280-A is a precision instrument especially designed to make possible a complete, accurate analysis of the composite television signal, for installing and maintaining transmitter and studio equipment in accordance with existing standards.

For permanent record of this analysis, oscillograms may be photographed from the screen of the Type 280-A with either the Du Mont Type 314-A or Type 271 Oscillograph-record camera.

This instrument now utilizes the new Du Mont Type 5XP—Cathode-ray Tube, resulting in an overall deflection sensitivity of 0.1 volt peak-to-peak per inch.

Pertinent to the television analysis, this increased sensitivity provides sufficient deflection of the composite signal to obtain a detailed analysis of the synchronizing pulses, without causing amplifier overload.

Both the high- and low-operating potentials of the Type 280-A are supplied by a separate unit contained in the Type 280-A.

HIGH VOLTAGE OSCILLOGRAPH INDICATOR UNIT

- Du Mont Type 5XP- Cathode-ray Tube; operated at accelerating potentials variable from 7,000 to 12,000 volts.
- Wide-band vertical amplifier provides deflection over three times useful scan.
- Frequency response to 10 megacycles (down 3db).
- Compensated, linear-sawtooth generator. Sweeps variable from 1 to 15,000 microseconds.
- A strobe marker output may be fed to a standard television monitor to determine the portion of the picture being displayed on the Type 280-A.

VIDEO SYNCHRONIZER AND DELAY UNIT

- Synchronizes the sweep-generator to either or both of the interlaced fields.
- A field and line selector and a vernier delay permit selection of any single line or portion of a single line on the T-V raster, for critical study.
- Will calibrate the sweep at intervals of 0.2, 1, or 10 microseconds per inch.
- Test-pulse output with fixed 25 microsecond delay.

DUMONT *for Oscillography*

ALLEN B. DU MONT LABORATORIES, INC., *INSTRUMENT DIVISION*, 1000 MAIN AVENUE, CLIFTON, NEW JERSEY

TELE-TECH's NEWSCAST

IRE National Convention Scheduled for March 6-9

The 1950 IRE national convention will take place on March 6-9 at the Hotel Commodore and Grand Central Palace, New York City, with "Behind the Scenes in Radio-Electronics" as the convention theme. Manufacturers displays will be exhibited at Grand Central Palace under the general exhibit title, "Spotlighting the New."

Seven especially planned symposia will be presented to Institute members.

The symposia and their sponsors have scheduled tentative programs as follows: Network Synthesis in the Time Domain; Circuit Groups; Nuclear Science and the Radio Engineers, Nuclear Science Group, Industrial Design; Broadcast and Television Receiver Groups, Engineering for Quality in Television, Quality Control Groups; Noise and Distortion in Sound Recording Transmission System, Audio Group; Basic Circuit Elements, Committee on Instruments and Measurements; Television, Special Committee.

New Motorola Laboratory

Plans for the erection of a new research laboratory and specialized production building in Phoenix, Arizona have been announced by Paul V. Galvin, president of Motorola, Inc. The building, a 40,000 sq. ft. single-story structure, will be ready for occupancy Mar. 1 and will supplement the laboratory now in use at 1100 N. Central Ave., Phoenix.

Weston Modernization Data

Modernization data is now available for owners of the earlier types of the Weston model 798 tubecheckers. All former types may be modified to include the latest tube calibration data. The conversion itself is not too difficult, and can easily be made by the user with simple tools. It is not necessary to return the checker to the factory. This conversion is advisable for Weston Model 798 Types 3, 3A, 4, 4A, 5, 5A, 6 and 6A Tubecheckers. For modernization data write to Weston Electrical Instrument Corp., 614 Frelinghuysen Avenue, Newark 5, N. J.

World Broadcasting Seminar

Dr. Arno Huth, in addition to his general courses on world radio, is commencing a seminar in international broadcasting. It will be limited to a small number of radio students and professionals particularly interested in international radio-communications.

Outstanding specialists in the field will participate as guest speakers. They are: Fernand Auberjonois, Chief French Section, International Broadcasting Division, U. S. Department of State; Kenneth D. Fry, Radio Director, former Chief of the "Voice of America"; W. Gibson Parker, Chief of Production, Radio Division of the United Nations, and several well-known technical experts.

The seminar, the first of its kind, will be devoted to basic research on technical and practical professional problems. It opens on Feb. 8 and runs for fifteen weeks, every Wednesday at 8:30 P. M. Admission only upon application to Dr. Huth, New School for Social Research, 66 West 12th St., New York City 11.

Built-in TV Antenna Systems In New Apartment Projects

Under contracts placed by a group of New York City realtors, Commercial Radio Sound Corp., RCA sound products representative in the New York area, is supplying RCA Television Antenaplex Systems which will be installed as integral engineering features of three large apartment projects on the same basis as heating, plumbing, and ventilating systems.

To obtain high quality reception from all stations, future tenants of these buildings will only need to plug their TV sets into an antenna wall outlet, in the same manner that the power cord is plugged into a utility outlet. This action by the New York group is believed to indicate a trend among metropolitan realtors toward making built-in television antenna systems available to the millions of apartment dwellers in TV areas throughout the country.

NEW NAMES & ADDRESSES

Storer and Schem, Cincinnati representative of the Ward Leonard Electric Co., Mount Vernon, N. Y., has changed their name to Sheldon Storer and Associates. The address remains the same—Transportation Bldg., 307 East 4th St., Cincinnati 2, Ohio.

* * *

Burlingame Associates, manufacturers' representative, and its affiliate, Brujac Electronic Corp., have moved to larger modern quarters at 103 Lafayette St., New York 13, N. Y. Fourteen field engineers cover the area bounded by Washington, D. C. on the south, Buffalo, N. Y. on the north, and extending eastward to the Atlantic Ocean.

* * *

Radio Engineering Laboratories of Long Island City, N. Y., has announced consolidation of operations into their main plant at 36-40 37th St., Long Island City 1, N. Y.

* * *

Gates Radio Co., Quincy, Ill., broadcast equipment manufacturers have opened a new factory branch at 2700 Polk Ave., Houston, Texas.

ONE MILLIONTH TV TUNER

G. E. Swanson (right), president of Standard Coil Products, Inc., Chicago, Ill., is presented with the company's one millionth TV tuner by J. R. Johnson, plant superintendent of the Los Angeles factor. It has been estimated that 40% of the TV receivers produced in the U. S. this year will incorporate the "Standard Tuner" as a component

Coming Events

January 11-13—Society of Plastics Engineers, Annual Conference, Hotel Carter, Cleveland, Ohio.

January 23-27 — American Standards Assoc., Five Day Seminar on Principles and Technics of Organizing Company Standardization Work, Room 501-A, Engineering Societies Bldg., 29 West 39th St., New York City.

January 30 - February 3 — American Institute of Electrical Engineers, Winter General Meeting, Hotel Statler, New York City.

February 6-8—Television Institute and Trade Show, 5th Annual Exhibit, Hotel New Yorker, New York City.

February 27-March 3 — American Society of Testing Materials, Committee Week and Spring Meeting, Hotel William Penn, Pittsburgh, Pa.

March 6-9—IRE 1950 National Convention, Hotel Commodore and Grand Central Palace, New York City.

April 5-7—Midwest Power Conference, Sponsored by Illinois Institute of Technology with cooperation of 18 universities and professional societies, Sherman Hotel, Chicago.

April 29 — IRE, Cincinnati Section, Fourth Annual Spring Technical Conference, Engineering Society Hdqtrs., Cincinnati, Ohio.

May 12-13—Armed Forces Communications Association, Fourth Annual Meeting, Astoria, New York City, and Fort Monmouth, N. J.

June 26-30 — American Society for Testing Materials, Chalfonte-Haddon Hall, Atlantic City, N. J.

New Philco Appointments

Larry F. Hardy has been named president of the television and radio division of Philco Corp. and Frederick G. Ogilby has been appointed vice president—sales of the same division. Joseph H. Gillies, vice president and a member of the board of directors of Philco Corp., will assume full responsibility for all TV-radio operations in his new capacity as vice-chairman of the division executive committee.

Raytheon Enlarges Tube Plant in Waltham, Mass.

As a result of the tremendously increased demand for cathode ray tubes, the Raytheon Manufacturing Co. has had to enlarge its power tube division plant in Waltham, Mass. Construction of a two story addition at the north end has just started which, when completed in April 1950, will result in the Waltham plant having a total of approximately 145,000 sq. ft. This plant is in addition to Raytheon's equipment manufacturing, sales and accounting department buildings in Waltham, and receiving tube and engineering buildings in Newton, Mass.

New National Moldite Rep

Appointment of Jerry Golten Co. of Chicago as midwest sales engineering representative has been announced by Sidney Lowenberg, sales manager of National Moldite Co., Hillside, N. J., manufacturers of magnetic iron cores.

The Case for U. S.-TV Standards in South America

Already the basis for the largest television operation in the world, U. S. television standards seem to be the logical selection for adoption by other existing and proposed television systems. As recently as last summer the first international television standards conference was held at Zurich, Switzerland, and attended by the representatives of eleven nations. Considerable interest was expressed in the U. S. standards and agreement was expressed with much of the reasoning behind them.

Irrespective of whatever standards are adopted common standards should undoubtedly be selected by all the countries in each continent. There do not seem to be any objections to this proposal and it is possible to detail innumerable reasons for it, among them being ease of interconnection of relays, reduction of equipment costs through greatly increased common markets, and vast resources of program material on which to draw.

The RMA is active in this field and the Engineering Department is making available RMA standards to trade organizations abroad. At the same time the Export Committee and the Transmitter Department are very active in promoting U.S. standards in South America. The region South of the Border is almost virgin territory as far as television equipment sales are concerned. As reported in Tele-Tech, the General Electric Co. has supplied a 5 KW television transmitter and a number of receivers to Televisao de Brazil to be used by PRA-9, Rio de Janeiro. But apart from this and a few other transactions very little has actually occurred to speed the adoption of U. S. standards.

At this time when the television industry is slowly coming to an ice-bound standstill due to delays on the part of the "Frozen Communications Commission" in its disposition of the hitherto unassigned VHF and UHF channels, an outlet to the south—or north—would be a boon to many manufacturers with overloaded transmitter stockrooms and personnel problems.

Naturally the various transmitter manufacturers concerned do not make known their plans and hopes for sales until the contract is signed, but it does seem that more vigorous activity along these lines is in order.

At present British receivers are of no value on this continent due to tuning range differences, scanning dissimilarities, and to a very minor extent, supply voltage characterestics. For the same reason sets made in this country are useless in Great Britain. If the preliminary work of the International Television Standards Conference is ratified and the proposition concerning the divorcement of the vertical frame repetition rate from the supply frequency is adopted, it will mean that, even if standards of 525/60 or 625/50 are used, no problem will be involved in applying simple modifications to make sets work in any country on either system.

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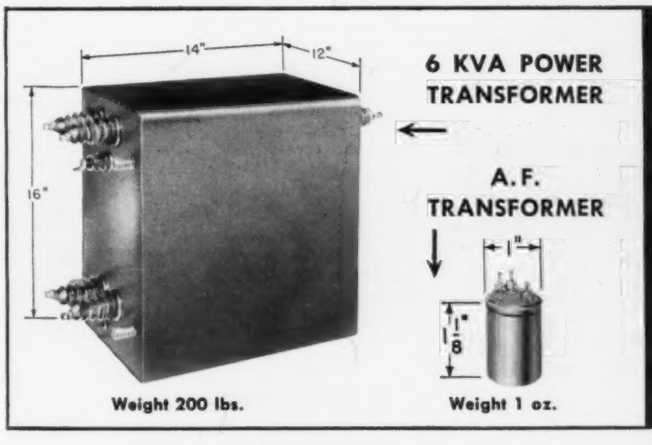

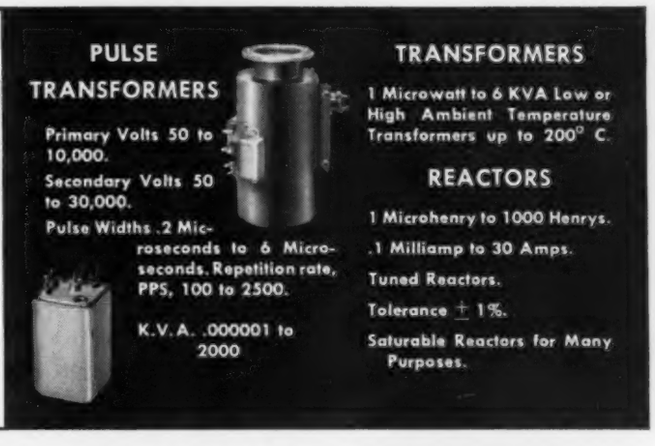
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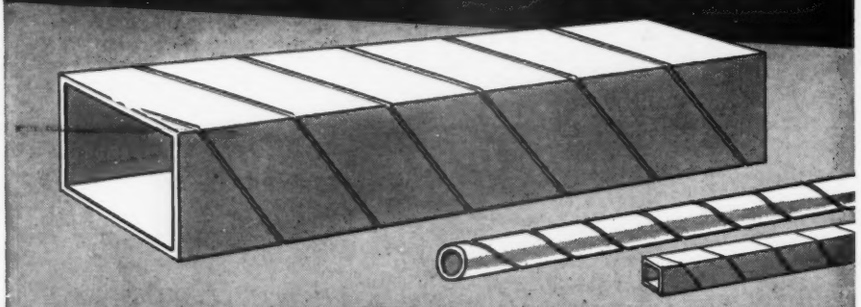

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PERSONNEL

Kenneth D. Turner has been appointed vice-president in charge of engineering for the Admiral Corp., 3800 Cortland St., Chicago 47, Ill. **Robert M. Jones** has been appointed director of engineering of the electronics division.

Lewis M. Clement, director of engineering and research, of the Crosley Division, Avco Mfg. Corp., Cincinnati, has been named chairman of the Executive Committee of the Receiver Section, RMA Engineering Dept. He succeeds Dorman D. Israel, executive vice president of Emerson Radio & Phonograph Corp., New York City.

Herbert DuVal, Jr. has joined Airborne Instruments Laboratory, Mineola, N. Y., as technical assistant to H. R. Skifter, president. His previous affiliations were with General Electric as head of naval electronics commercial activities and later v-p. of WPTR, Albany, N. Y.

John A. Hickey, associated with the Radio Receiving Tube Division of Raytheon Mfg. Co., as a radio tube application engineer for the past fifteen years, has been appointed as an engineering field adviser in the Raytheon Replacement Tube Dept., Newton, Mass.

The directors of Zenith Radio Corp. have elected **Dr. Alexander Ellett** vice president in charge of research, according to an announcement by **Commander E. F. McDonald, Jr.,** president. Dr. Ellett has headed Zenith's research laboratories since 1946 and one of his major contributions has been to Phonevision which he made commercially practicable. Phonevision is Zenith's method of combining the telephone wire with regular television transmission to provide pay-as-you-see home viewing.

Vincent C. Hall, Jr., of 1515 Veterans Foreign Wars Parkway, West Roxbury, Massachusetts, is now associated with the Applied Physics Dept. of National Research Corp., Cambridge, Mass.

TV Interference

(*Continued from page* 29)

arrangements have been considered. The commercial form of one effective circuit is shown in Fig. 4. It consists of two-half sections, one at end end ($m = 0.6$) with their attenuation factor peaked at 40 MC, with two intermediate low-pass sections in the center, giving an effective attenuation of over 80 db. Fig. 3b shows practical values for

a filter for use with line impedances of 52 to 72 ohms.

The constants selected may be altered according to the values in the table by selecting other values of cut-off frequencies should it be necessary to attenuate some unusually strong harmonic present.

The several arrangements which are pictured and described are the work of Russell Valentine, engineer for New York's high fidelity station WQXR and amateur station at the instigation of the Electronic Distributing Co., 43-35 Douglaston Parkway, Douglaston, N. Y., who are producing these filters shown here, as complete units or in kit form.
Figures 4, 5, 6, Courtesy of Eldico.

Gated Beam Tube

(Continued from page 23)

Fig. 7 shows the limiter-discriminator circuit designed for operation in AC-DC receivers. At the standard FM intermediate frequency of 10.7 MC, the output voltage for 75 KC deviation is approximately 4.5 volts rms. The AM rejection defined as the ratio of AM output voltage to FM output voltage taken with 30% AM and 30% FM simultaneously can be optimized to approximately −35 db. The AM rejection characteristic with respect to input signal level is irregular but is such that at least 20 db of AM rejection is realized at input voltages of 1 volt, and 15 to 30 db of AM rejection is realized at signal voltages above the optimized level of 1.25 volts rms.

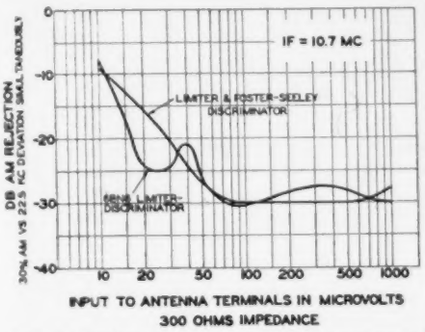

Fig. 8: Performance characteristic compared with standard limiter and discriminator

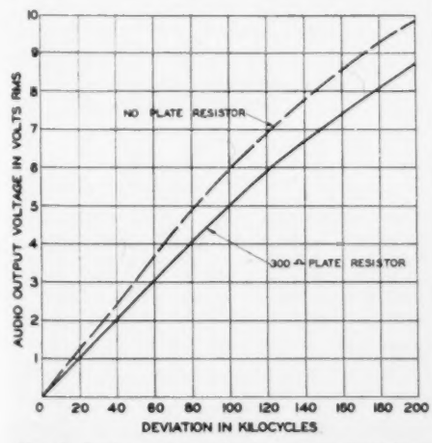

Fig. 9: Audio output voltage versus deviation

Fig. 8 shows the remarkably wide and linear variations of plate current with instantaneous frequency and indicates as well the effect of the 300 ohm series plate resistor upon this characteristic while Fig. 9 shows the relationship between audio output voltage and deviation. This latter figure also indicates the effect that the series plate resistor has on both output and linearity. It should be noted that an increase in output voltage from 3.75 to 4.5 volts rms is realized by the omission of the series plate resistor. However, in receivers in which it is desired to keep harmonic distortion to a minimum, the use of the plate resistor will give output with less than 1% distortion whereas omitting the resistor will give somewhat greater output at approximately 3% distortion. The output voltages shown are obtained using accelerator voltage of 60 volts and plate supply voltage of 80 volts. Higher accelerator and plate voltages and a correspondingly higher plate load resistor yields audio output of 15 volts rms for 75 KC deviation.

Part Two will appear in the February issue.

FOR
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is an excellent mechanical unit for high speed evacuating in cathode-ray and television tube production. This pump is proved for fast initial evacuation and dependable and trouble-free service. Makes an ideal unit for backing glass or metal diffusion pumps. Speed at 1 micron, 375 ml; vacuum, 0.1 micron or better. Specify No. 92015A Cenco-Megavac Pump mounted with base and motor for 115 volt, 60 cycle AC operation. $195.00

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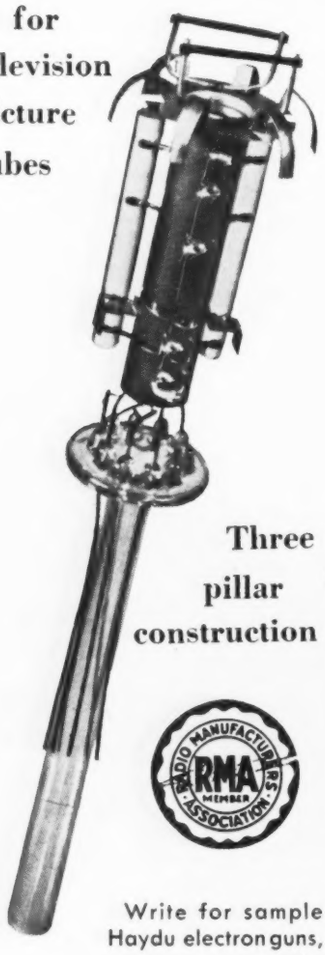

Three pillar construction

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REPORT ON COLOR-TV

(Continued from page 36)

Preceding the next comparative demonstration, mentioned above, will be the test of the CTI system before the FCC on Feb. 20. It is expected that CTI will be able to put on a demonstration in Washington on this date but that the picture quality will not equal either of the systems mentioned in this report, mainly due to interline flicker which is reported to be visible at viewing distances of even 12 times the picture height. Additional direct testimony and cross-examination will start Feb. 27.

FCC has issued a notice concerning Field Tests. It asks manufacturers to conduct tests on apparatus used in the CTI, CBS and RCA systems and also for TV reception data in the UHF band. The subjects to be covered are numerous, for instance, regarding Color: picture quality; desired to undesired signal ratios for co-channel and adjacent channel conditions, signal to noise, compatibility, and the like. The UHF tests cover: transmitter power, frequency stability and side-band filters; receiver characteristics and propagation.

If the lifting of the freeze and the allocation of the UHF band must wait upon the color decision—and it is not clear why it must—then the FCC will be under increasing pressure to take action so as not to hamper the continued growth of Television in 1951-52.

Technics in Frequency Adjustment of Quartz Crystals

Methods of changing the frequency of high-frequency thickness-shear quartz crystals are presented in detail in a new circular, "Fundamental Techniques in Frequency Adjustment of Quartz Crystals", published by the National Bureau of Standards and now available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., at 10 cents a copy.

New TV Color System

The Prismacolor Corp. of 1902 South Western Ave., Chicago, Ill. has announced that it has a new color system for television use. The company's president, Mr. Frederic Oakhill, said that details were not available at this time due to current negotiations, but that they would be released as soon as possible.

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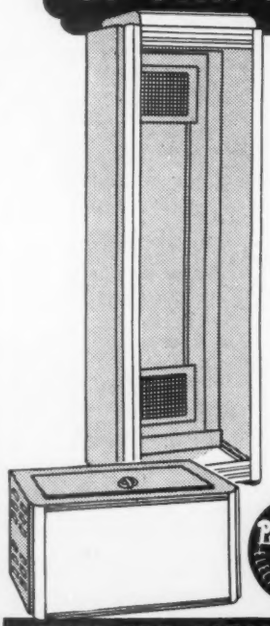

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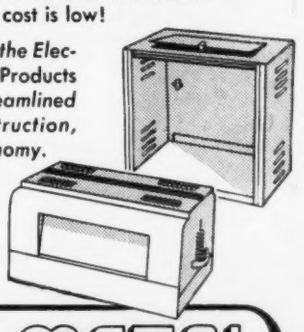
Because we specialize in the Electronics field, Par-Metal Products excel in functional streamlined design, rugged construction, beautiful finish, and economy.



Remember, Par-Metal equipment is made by electronic specialists, not just a sheet metal shop.

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BULLETINS

Television Lighting Equipment

Century Lighting Inc., 419 West 55th St., New York 19, N. Y., has released a new catalog (No. 3) on Television Studio Lighting. All types of spots, arcs, and special effects equipment are included. Century has also published catalogs on Theatrical Lighting (No. 1) and Architectural Lighting (No. 2). (Mention T-T)

Laboratory Power Equipment

A catalog sheet (Form 549-MG) on Katolight motor generator sets has been released by the Kato Engineering Co., 1415 First Ave., Mankato, Minn. These new machines are useful for production testing of electrical devices built for export requiring special voltages and frequencies, and also for laboratory applications. (Mention T-T)

UHF Precision Measuring Instruments

Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif., has issued a new catalog devoted entirely to UHF equipment. Three signal generators, covering the 450 to 4000 MC band, are described. Calibrated slotted lines and standing wave indicators combine with microwave power meters and ancillary apparatus to offer a very complete line of UHF measuring units. The 16-page handbook and loose 4-page insert listing other HF equipment manufactured by Hewlett-Packard, as well as addresses of field representatives, forms a useful reference for engineers. (Mention T-T)

Clutch Head Screws

The United Crew and Bolt Corp., 2513 West Cullerton Ave., Chicago 8, Ill. has published a new catalog describing its comprehensive line of clutch head screws and drivers. The use of recess and mating driver on assembly lines have resulted in production increases from 15 to 50%. (Mention T-T)

Mixing TV Signals

(*Continued from page* 18)

lator provided the sine wave necessary for phase shifting and was first operated at 15,750 cps with the plate circuit tuned to the second harmonic 31,500 cps. The 31,500 cps signal is necessary to lock in the master oscillator in the sync generator TG-1A. This provided a rigid lock, but some jitter was noticeable at the top of the picture. The oscillator was changed to operate at a frequency of 31,500 cps resulting in a very stable operation without jitter. Since the latter change it is assumed that it is possible to eliminate a transformer T-2 and tube V-4, thus simplifying the circuit and reducing components. The primary of T-3 would then be in the plate circuit of the oscillator and tuned to 31,500 cps.

The basic idea in this article was obtained from an article on Interlocked Scanning for Network Television by James R. De Baun, NBC-TV, N. Y., in the RCA Review, December 1947. Acknowledgment is due F. J. Gaskins of NBC-TV, Washington, D. C., for his specific contribution to this project.

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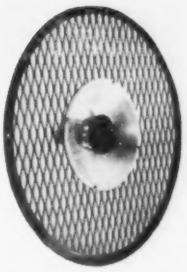
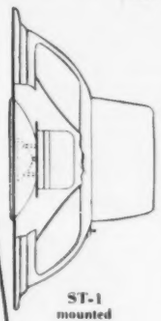


ST-1 with mounting screen



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Height, less screen	5¼ in.
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ORIGIN OF TERM "ELECTRONICS"

(*Continued from page* 18)

M. Clements and O. H. Caldwell were then working on for initial publication in January, 1930. Mr. Long had dropped into Mills' office on another matter and happened to hear Mills' suggestion made to the callers. A few days later Mills further discussed with Long the possible scope and suggested name of the new magazine. Both occurrences are recalled clearly by Mr. Long, despite the 20-year interim.

Abstracts from Chronology "from 'Electricity' to 'Electronics'"

1904—We now begin to find in the literature the use of the term "electronic". One instance is that of a paper given by Prof. P. Drude at the International Electrical Congress of the St. Louis Exposition, entitled "Electric Conduction in Metals, from the Standpoint of the Electronic Theory." (See Transactions of International Electrical Congress, St. Louis, 1904, pub. 1905, Vol. 1, p. 317.)

1905—This year saw the beginning of the publication of an annual that continued many years under the title "Jahrbuch der Radioaktivität und Elektronik", edited by Johannes Stark of the well-known "Stark effect". This book carried in it annually a review of the "Literatur der Elektronik". This literature included even the optics of the electron, and altogether is such that we can interpret the word "Elektronik" in the title as nothing less than "Electronics". This early yearly was devoted to the scientific rather than the technological side of the subjects. It proves to have been far-sighted in joining together two subjects that now are becoming as one.

1914-15—An International Congress for Radioactivity and *Electronics* (Radioaktivität und Elektronik) to be presided over by Prof. Rutherford, was scheduled to be held in Vienna, 1915. (E.T.Z. 13 Aug., 1914 (Vol. 35) p. 944). The meeting was, of course, prevented by World War I. The term Elektronik Kongress, appears in the general index of E.T.Z. published 1928.

LLOYD ESPENSCHIED

Dr. Robert Millikan Urges Further Research

Dear Dr. Caldwell:

Replying to your letter of November 9th, I first began to rack my brains as to when I myself first heard the word "electronics" introduced to designate a division of physics, and at once set to work to look up what I presumed would be the most authoritative source of information on that subject, namely, the back volumes of "Science Abstracts."

Unless I am mistaken, up to the date the subject of electronics as one of the subdivisions of physics is not recognized at all in physics itself.

On the other hand, in the yearly volume which is labeled "Section B, Electrical Engineering," the word "electronics" does appear as one of the headings of the major subdivisions in the subject index, and has been so listed for at least fourteen or fifteen years in that way.

These volumes of "Science Abstracts" are available in all laboratories and libraries, if you want to get a more refined search.

Hoping this will give you a steer to the answer to your question, I am

Very cordially yours,

ROBERT A. MILLIKAN

California Institute of Technology
Pasadena, Cal.

Dr. de Forest First Heard Term From Clements and Caldwell

Dear Dr. Caldwell:

Regarding your inquiry about "electronics", I had never heard the word prior to that Lotus Club luncheon in New York City in 1929, when you and Clements suggested it as a good title. It is! Kind regards.

LEE DE FOREST

Lake Shore Club
850 Lake Shore Drive
Chicago 11, Ill.

French Had a Word for It in 1928

A famous electronic pioneer who asks that his name be omitted, calls to our attention the use of the French equivalent "electronique" in a book by Marcel Boll and Charles Salomon published in Paris in 1928 by Gaston Doin et Cie, 8 Place De L'Odeon 8. Reference to this volume appears in

(*Continued on next page*)

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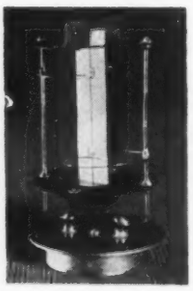

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JK CRYSTALS

Chemical Abstracts, Page 2368, Vol. 23, May-August, 1929.

Other Early Electronic Dates

As cited in our issue last month, the word "electron" was coined by Dr. G. Johnstone Stoney in 1891.

In 1913 or 1914, Dr. E. F. W. Alexanderson of GE perfected what he then called an "electronic amplifier". See Archer's History of Radio, page 120.

In 1919, the term "electronic" appeared in the Gherardi-Jewett paper on "Telephone Repeaters". See Proceedings A. I. E. E. Nov., 1919.

Single Pulse Recording

(*Continued from page* 33)

the near slope of the hill; the hill is cancelled by the MTI although the signal from the aircraft remains.

A series of photographs have been made of noise and signals in noise when the amplitude of the signal is approximately equal to the value of the noise, Figs. 9 to 12. The signal was produced by a radar test signal generator (10 cm) (TS 197CPM4), the pulse width being 2 microseconds. The pulse repetion frequency is 300 pps. The signal was fed through a test T/R tube, into a receiver, and attenuated until its value was equal to noise. The S/N ratio was determined by observing an A Scope.

Fig. 9 is a conventional time exposure of 1/5 sec. duration. It therefore has recorded 60 sweeps. Figs. 10 and 11 are photographs of individual sweeps. In Fig. 10 the signal is readily discernible from noise while in Fig. 11 the noise bursts have obscured the fixed signal. The sweep length in all three plates is 25 microseconds. Finer detail is shown in Fig. 12 because the sweep length has been changed to 5 microseconds.

The author wishes to express his indebtedness to Mr. Henry Kaufmann, Chief of the Radar Laboratory, who directed the research; to J. A. Kelly and W. A. Nadeau who were in charge of the Radar; to Chester Malik and George Duvall who designed the oscilloscope modification; to F. Metz and M. Morelli who are assisting in the analysis of the data; to John Buckley who directed the fabrication of the optical system; and to A. Shulman and A. Metro who were in charge of communications.

[1]The Photography of Successive Pulse Reflections from a Moving Target, Radiation Lab Report #64-5, June 12, 1942, J. L. Lawson.
[2]Goldstein and Bales, Radiation Lab Report #569, 1944.
[3]Goldstein and Bales, "High Speed Photography of the Cathode Ray Tube"—Review Scientific Instruments, Vol. 17, #8, March 1946.
[4]Goldstein, Radiation Lab Report #42, January 25, 1945.
[5]Radar System Engineering—Ridenour-McGraw Hill, 1947.

20-KC Recording

(*Continued from page* 15)

or 2.5 mil needle. With this arrangement the public therefore could enjoy all their old library selections and also have the advantage of present potential quality with the standard 2.5 mil needle. In addition, users of the LP attachments are still able to play V-groove 78 RPM work with the 1.0 mil needle to even better advantage.

The playback pickup and amplifier-speaker system was selected to reproduce these records with attention to handle the wide frequency response, the large dynamic range (at an average modulation level considerably above that usually found on records) and lowest intermodulation distortion. These details will be taken up in a later article.

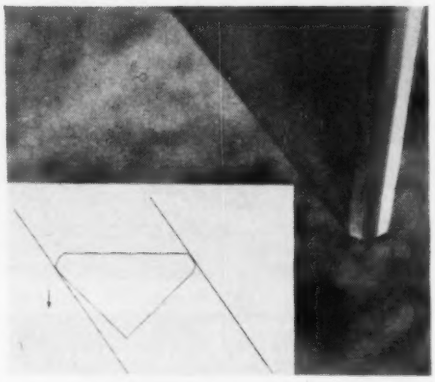
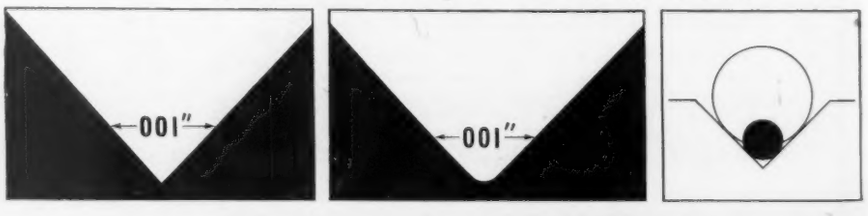


Fig. 6: "V Groove III" stylus showing three burnishing facets (enlarged 360 times). Inset shows action of faces on wall of groove

Fig. 5: (left and center) Contour photos of the V and U grooves with position of one mil width indicated on each. At right (Fig. 7) sketch shows how V groove will accommodate both the 1 mil stylus (black circle) and the 2½ mil stylus (white circle)



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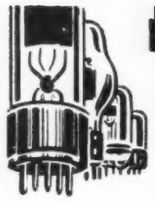

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1Q5GT	.85
1R4/1294	.65
1S5	.70
1T4	.75
2A3	1.05
2A7	.85
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2B22 GL559	3.75
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6D6	.60
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6L7	.75
6N7	.75
6R7G	.75
6SA7	.65
6SC7GT	.70
6SF5	.65
6SG7	.65
6SH7	.40
6SJ6GT	.60
6SK7GT	.60
6SL7GT	.60
6SN7GT	.80
6SQ7GT	.60
6SR7	.60
6SS7	.60
6U7G	.85
6V6GT	.75
6Y6G	.75
7-7-11 Ballast	.35
7A4	.60
7A7	.60
7B4	.60
7C4 1203A	.40
7E6	.60
7F7	.70
7H7	.70
7K7	.70
7L7	.70
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12H6	.40
12J5GT	.40
12J7GT	.70
12K8	.65
12SF7	.70
12SG7	.65
12SH7	.40
12SK7	.60
12SL7GT	.60
12SQ7GT	.60
12SR7	.60
12X825 2 amp. Tungar	2.10
13-4 Ballast	.35
14B6	.75
15R	1.20
REL-21	2.75
23D4 Ballast	.45
RX24	1.75
24A	.75
25Z6GT	.55
26	.65
27	.50
28D7	.40
30	.75
30 (VT-67) Walkie	.75
33 (VT-33) Talkie	.75
34	.35
RK-34	.45
35Y4	.65
36	.40
37	.40
38	.40
39 44	.35

TYPE	PRICE EACH
45 Spec.	.50
46	.75
EF50/VT250	.45
56	.65
70L7	1.05
72	1.75
RKR-73	1.25
76	.55
77	.55
VR-78	.65
80	.45
FG-81A	3.95
83V	.90
89Y	.40
VR-90	.65
VR-92	.65
100R	2.75
FG-105	9.75
VR-105	.85
VU-111-S	.55
1148	1.20
117Z3	.55
VT-127 British	.35
VT-127-A (Triode)	2.95
VR-150	.50
VT-158	14.95
FG-172	19.75
205B	1.45
211 (VT4C)	.60
215A	1.75
221A	2.10
231D	1.20
268A	2.95

TYPE	PRICE EACH
304TH	5.75
304TL	1.75
307A	4.25
316A	.75
350B	2.55
354C	14.95
371A	.95
371B	.85
388A	3.95
393A	4.65
395A	4.95
MX408U	.40
417A	14.50
434A	3.40
446A	1.55
450TH	17.95
471A	2.55
527	9.95
530	9.95
531	12.95
532A.1B32	3.55
GL-559	3.75
KU-610	7.45
HY-615	1.05
700B	7.95
700C	7.95
700D	7.95
702A	2.95
703A	3.95
704A	1.75
705A	2.65
707A	17.50
707B	19.50
708A	4.95

TYPE	PRICE EACH
710A	2.45
713A	1.55
714AY	3.90
715B	9.75
717A	.85
721A	3.75
723AB	14.95
724A	4.25
724B	4.25
725A	9.95
726A	17.45
730A	10.95
801	.50
801A	.70
803	5.25
804	9.95
805	5.95
807	1.25
808	1.65
811	2.35
813	7.85
814	3.75
815	2.85
826	.75
829B	4.95
830B	3.95
834	5.75
837	1.65
838	3.25
841	.50
843	.50
851	39.00
860	2.40
861	29.25

TYPE	PRICE EACH
864	.45
865	2.55
866A	1.30
869	19.95
869B	27.25
872A	2.45
874	1.95
878	1.95
930 Photo Tube	1.00
954	.45
955	.55
956	.50
957	.45
959	.55
991 (NE-16)	.30
1005	.35
1148	.35
1201	.75
1203A/7C4	1.05
1616	1.25
1619	.45
1624	1.25
1625	.45
1626	.45
1629	.40
1630	3.95
1638	.90
1641/RK-60	.75
2051	.75
7193	.30
8011	2.25
8012	3.25
8020	3.25
8025	6.75
9001	.65
9002	.45
9003	.60
9004	.40
9006	.40
38111A	.45

NEON BULBS

NE-11	.24
NE-16	.24
NE-20	.06
NE-21	.24
NE-48	.24

PILOT AND FLASHLIGHT BULBS

STOCK NO.	MFR. NO.	VOLTS	WATTS	BULB	BASE	PRICE-EACH
342-5	1256	6	21CP	S-8	DC Spec.	$0.05
350-41	943	6-8	100CP	G-16½	Auto Soc.	.10
354-76	1491	2.4	.8A	G-7	DC Bay.	.09
LB-200	S6	115	6	S-6	Cand. Screw	.16
350-43	11A/T4C	18	.11A	T-4	Cand. Screw	.14
342-6	1245	6	3CP	G-6	SC Spec.	.08
LB-201	319	3	(Aircraft, metal housing, Amber Lens)			.22
LB-202	328	24	"	T-1¾	Pressure Flange	40
350-40	64	6-8	3CP	G-6	DC Bay.	.07
350-42	Spec.	12	6A.	S-6	Cand. Screw	.13
350-20	1446	12	.2 amp.	G-3½	Min. Screw	.07
350-14	49	2	.06	T-3¼	Min. Bay	.06
348-22	PR-10	6	.5 amp.	B-3½	Min. Flange	.05
350-19	Proj. Bulb	120	500 W.	T-20	Med. Pf.	1.45
LB-17C	24B	24	.035 a.	T-2	Tel. Base	.18
LB-58A	Nite Lite	110	7W	C-7	Cand. Scr.	.17
LB-57A	53	12-16	1 CP		Min. Bay	.07
354-78	Airplane Headlite	24	239W	A-19	Med. Pf.	.38
350-55	323	3	(Aircraft)	T-1½	953	.22
342-3	LM-60	115	250W	T-20	Med. Pf.	.40
LB-102	1195	12-16	50CP	RP-11	DC Bay	.14
342-2	CC-13	110	100W	T-8	DC Pf.	.33
354-76	1491	2.4	.8A		DC Bay.	.14
354-77	302	28	(Airplane Type)		DC Bay.	.14
LB-104	313	28	.17A	T-3½	Min. Bay	.11
350-24	12A	12	.09-.11A	T-2	Tel. Base	.18
LB-107	24-A2 WE	24	.75-.105A	T-2	Tel. Base	.18
350-63	AR-1 Argon	105	2½W	S-14	Med. Screw	.22
LB-109	5122		Telephone Type Neon	T-2	Tel. Base	.17
350-18	1477	24	17	T-3	Min. Screw	.16

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